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(*Continued from page 112*)

PRESIDENT W. D. HUNTER: The next paper will be by Mr. W. J. Schoene on "Notes on Comparative Tests with Zinc Arsenite and Arsenate of Lead."

NOTES ON COMPARATIVE TESTS WITH ZINC ARSENITE AND ARSENATE OF LEAD

By W. J. SCHOENE

The statement has been made that in proportion to its arsenical content zinc arsenite is more toxic to insects than arsenate of lead. In order to determine this point feeding tests were arranged to secure more data regarding the comparative efficiency of these poisons. At the same time experiments were made to determine the effect of zinc arsenite on foliage.

Most of the feeding tests were made in the laboratory, the foliage being usually sprayed with an aspirator. Sometimes leaves were taken from especially treated trees in the field. Arsenate of lead and zinc arsenite were used singly and in combination with bordeaux, lime-sulphur, molasses, glucose, soap, glue and lime. One sample of lead arsenate paste was taken as a standard for comparison and the poisons were used at the rate of 3 pounds of lead or 1 pound of zinc to 50 gallons of spray. The lead contained 17.75 per cent arsenic oxide and the zinc 40.28 per cent arsenious oxide. To ascertain its safeness to foliage zinc arsenite was applied to apple, pear, peach, elm, willow, cabbage and potato. The insects employed in the feeding tests were the spiny-elm caterpillar (*Euvanessa antiopa* L.), fall web-

worm (*Hyphantria cunea* Dru.), zebra caterpillar (*Mamestra picta* Harris), and willow beetle (*Lina scripta* Fab.). This paper deals with the effects of these compounds on the insects and on apple foliage.

The results of the feeding tests are briefly summarized as follows:

(1) The most striking difference in the action of the poisons was noted in several experiments when the caterpillars were on the tree at the time of treatment or placed on the foliage while it was wet with the spray. Under these conditions the zinc had double the speed, as compared with the lead poison. This difference was not so noticeable with larvæ of the willow beetle.

(2) In all of the other feeding tests there were no important differences regarding speed of action in favor of either poison. The results varied but the zinc combinations were slightly quicker in most experiments.

(3) Likewise there was no great difference in the sticking properties of these poisons. The adhesive quality was very well shown in some tests in which the sprayed foliage was subject to the action of the weather for periods of 3 days, 8 days and 24 days. The conspicuous result of these latter experiments is that, both when first applied and when subject to weather action, zinc arsenite or arsenate of lead used alone were equal in effectiveness.

(4) All the combinations were at first more or less repellent, but when exposed to the weather the poisons in question, either singly or with lime-sulphur, soon lost this quality and became more attractive to the caterpillars; while with combinations containing bordeaux and soap there was only a slight loss in the repellent properties during the experiment. With most of the combinations a reduction in efficiency was coincident with the loss of the distastefulness of sprayed foliage.

In our spraying experiments zinc arsenite did not injure apple foliage when used with lime or with bordeaux mixture. There was slight marginal injury in one experiment with lime-sulphur. In all of the other tests where zinc was used alone or in combination with soap or glucose there was more or less browning of the margins of the leaves with crescentic rings about ruptured areas in the epidermis.

PRESIDENT W. D. HUNTER: This paper is before the Association for discussion.

A. W. MORRILL: I have been especially interested in arsenite of zinc during the past season in connection with the control of the bean lady bug. The foliage of the bean appears to be unusually susceptible to injury by arsenical insecticides. Our experiments so far are not conclusive, but the brands of zinc arsenite so far tested on the bean have been a little more injurious than arsenate of lead.

Apparently different lots prepared by the same manufacturers differ considerably in regard to injuriousness to plants. The "Ortho" brand arsenite of zinc is now recommended by the manufacturers to be used with equal parts of commercial iron sulphide. This is said to neutralize the injurious effects.

PRESIDENT W. D. HUNTER: Any further discussion. The chairman believes that Dr. Ball is not present. The next paper is by W. C. O'Kane, on "Arsenical Residues on Fruit."

ARSENICAL RESIDUES ON FRUIT

By W. C. O'KANE, *Durham, N. H.*

(Withdrawn for publication elsewhere.)

PRESIDENT W. D. HUNTER: Any discussion on this paper?

MR. E. P. FELT: I was interested in the paper because for some years questions have been coming to me along that line. We all know that the amount of arsenate of lead used for spraying shade trees has been increased. Our experiments show that arsenate of lead remains on the trees some time. I believe in using poisons, and even after hearing the evidence, we should all be careful and not advise the use of too much.

MR. C. L. MARLATT: I would like to inquire as to the cumulative effects of arsenate of lead.

DR. HALL: In reply to this question I will say as a physician, and not as an entomologist, that arsenic is a drug that one can get a tolerance for. Small quantities act as a tonic and the amount that can be taken without showing any serious effects can be increased from time to time.

MR. R. W. BRAUCHER: In regard to animals being injured by lead poisoning, I will say that in an orchard where I worked last summer one cow was killed and two made sick. Investigation showed that the trouble was not caused from spraying but was due to the animals licking the dry residue on the inside of some of the barrels which had contained lead and which were carelessly placed on a dump in the pasture.

MR. A. F. BURGESS: I would like to make one suggestion in regard to the results of experiments given in the paper by Mr. O'Kane. You will note that the spraying was carried on in August shortly after the small brown-tail caterpillars had hatched. Such spraying of course, leaves a heavy residue on the foliage and fruit, but it is not necessary to spray at this season of the year except in regions where the brown-tail moth exists. In nearly all the orchard sections

of the United States it would not be necessary or desirable to spray with poison so late in the season and this being the case the poison which would remain on the fruit from ordinary spraying, would be much less than the amounts recorded in the paper presented.

PRESIDENT W. D. HUNTER: The next paper will be by Mr. G. D. Shafer on, "How Contact Insecticides Kill."

HOW CONTACT INSECTICIDES KILL

By G. D. SHAFER, *Lansing, Mich.*

(Withdrawn for publication elsehere.)

PRESIDENT W. D. HUNTER: As the amount of time remaining is very limited it has been suggested that Dr. Felt's paper be read and discussed and that the remaining papers be placed on the program for the next session. If there is no objection we now will listen to the paper by Dr. Felt, entitled, "Injuries Following the Application of Petroleum and Petroleum Products to Dormant Trees."

INJURIES FOLLOWING THE APPLICATION OF PETROLEUM OR PETROLEUM PRODUCTS TO DORMANT TREES

(Abstract)

By E. P. FELT, *Albany, N. Y.*

Attention was called in a summary manner to earlier injuries in New York state by petroleum or mechanical emulsions of the same. More recent damage following the application of miscible oils to hard maples and apple trees was briefly described. The conclusions reached were as follows:

The use of oils or oil preparations on dormant trees has been followed in several cases by severe injury.

Trees, as living organisms, respond to climatic and cultural conditions and, as a consequence, their power of resisting penetration and injury by oils undoubtedly varies with the season and probably from year to year.

Since certain weather conditions promote injury by oils, it appears impossible to be certain that deleterious effects may not follow spraying trees with an oil or oil preparation.

Fall treatment with an oil appears to be more hazardous than spring applications.

Other things being equal, we believe there is less danger of peneration by oil and a consequent injury if the applications are made

in the spring shortly before active growth begins, and presumably offers greater obstacles to entrance by oil or quickly replaces destroyed and necessary vital tissues.

PRESIDENT W. D. HUNTER: This paper is now open for discussion.

[The following has been supplied by Mr. Yothers as a substitute for his remarks. Ed.]

THE EFFECTS OF OIL INSECTICIDES ON CITRUS TREES AND FRUITS[1]

By W. W. YOTHERS, *Bureau of Entomology*

The effect on citrus trees and fruits of those commercial and home-made insecticides having a mineral oil base is of primary importance. This is especially the case since these are the only kinds of insecticides which have been found up to this time to be effective in controlling the white-flies, and the grower who desires to spray has no alternative. Their effectiveness against scale insects and rust mites also increases the importance of this subject.

As a general proposition their use is attended with little, if any, danger to the trees or fruit. On the other hand, the killing of the insects results in great benefit to the tree. There are certain chemicals, however, which usually cause damage when applied to the trees in the form of a spray and there are certain practices which should be followed in the use of oil sprays on citrus trees.

The use of sulphuric acid in a spray should be avoided. One brand of commercial miscible oil contained 2½ per cent of sulphuric acid according to the analysis of the Bureau of Chemistry. Dozens of tests were made with this insecticide and every one resulted in some form of injury. When used at a strength of 1½ per cent of oil or 1 part of insecticide to about 55 parts of water in the winter, a large part of the leaves fell and holes were burned in others that remained on the trees. So far as observed no twigs were killed. It is very doubtful, however, if this in the least made the following crop of fruit less. When used in April when the oranges were about ½ to ¾ inch in diameter, at 1 per cent of the oil contents the new leaves were injured and many new and old leaves fell. About three fourths of the crop of fruit fell or was so badly scarred as to be unsalable. When used in April at ½ of 1 per cent of the oil contents or about 1 part of insecticide to 170 parts of water, it burned holes in the new leaves, and the results even at this weak dilution were so disastrous as to prevent

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[1] Published by permission of the Chief of the Bureau of Entomology.

its use. Since it requires a dilution of spraying material containing approximately 1 per cent of oil to be effective against the insects further experiments were discontinued. According to our observations this acid did not increase the insecticidal qualities of the spray. We were unable to test sulphuric acid in any of the formulæ since it always prevented the emulsification of the oil by the soap.

The use of rosin or rosin oil should also be avoided. One brand of commercial miscible oil contained a considerable percentage of rosin oil and this, while not so injurious as sulphuric acid, burned the leaves and fruit when used at 1 per cent of the oil contents. The use of rosin oil in the home-made products always resulted either in great damage or unfavorably. One sixth of 1 per cent used in a spray containing 2 per cent of oil caused many more leaves to fall than where the same amount of oil in a spray without the rosin oil was used. When used in May on oranges 1½ inches in diameter at 1 quart rosin oil to the emulsion required to make ½ of 1 per cent of petroleum fuel oil for 200 gallons of water or ⅛ of 1 per cent of rosin oil, large areas were scarred. This injury was usually found on the lower part of the orange where the drop of spray had collected. Rosin oil did not increase the insecticidal qualities as much as it was expected and since it costs about three times as much as the paraffine oil, we strongly advise against its use.

Experiments with another miscible oil, made on the same dates and in the same groves, using exactly the same percentages of oil as was used in the experiments with the above brands, gave only good results. It did not burn the leaves nor fruit and did not cause an excessive shedding of leaves in the winter. The analysis showed this product to be free from sulphuric acid and rosin oil, and to contain only such chemicals as were necessary for the proper emulsification of the oil used in its manufacture.

Much work was done with emulsions of petroleum fuel oil 24° Baumé, distillate or gas oil 28° Baumé, and two paraffine oils of 24° and 28° Baumé, respectively. The extensive use of these oils at proper strengths did no immediate damage to the foliage or fruit.

While it is a fact that oil sprays made without injurious chemicals and used properly cause no immediate damage and never any serious injury, they apparently interfere to a limited extent with the physiological processes of the tree. On March 30 and 31, 1911, a row of about 20 trees each was sprayed with petroleum fuel oil 1 per cent, distillate oil 1½ per cent, paraffine oil 28° Baumé 1 per cent, and paraffine oil 24° Baumé 1 per cent. At the time of the application the leaves were the new ones of the first spring growth and had not become very green but were of a light yellowish green color.

After about two weeks it was noticed that the leaves of those trees that had been sprayed were still of a slight yellowish green and those left unsprayed had changed into a dark green. At the end of a month this difference had entirely disappeared, and so far as could be ascertained no permanent injury had been done. Although some difference may have existed according to our observations, none could be detected between those leaves sprayed with the distillate which was somewhat volatile and the heavy paraffine oil of 24° Baumé, which was very stable. This observation would indicate that the coating of the new leaves with oil spray interfered to a limited extent with the formation of chlorophyll.

The excessive use of sprays may be injurious and some tests were made to determine the accumulated effect of one of the above oils. The same trees were sprayed with the paraffine oil 24° Baumé using 1½ per cent of oil in the spray three times at intervals of six weeks during the summer, the first application being made May 13, 1911. The effect of these repeated applications was very marked. The leaves were small as compared with those from other trees. There were considerable dead twigs in the trees and the fruit was very small and very late and sour compared with the fruit from adjoining trees. There was no yellowing of the leaves, nor burning of the leaves nor fruit by these applications. The trees sprayed only once on May 13 and a check on the above were much improved by the application. It should be stated that a single application of a spray containing 1 per cent of the above oil instead of 1½ per cent as was used would have been sufficient to eliminate the damage caused by insects. No experiments were conducted to determine the accumulated effect of as weak a dilution as ½ of 1 per cent of oil but it is the opinion of the writer that such a dilution would not be injurious even though used very frequently.

The weather conditions which may exist at the time of the application may be of much importance. It has been known since Hubbard made his investigations that low temperatures following the application of kerosene emulsion would result in injury. This is due to the low temperatures preventing the evaporation of the kerosene, thus permitting it to remain for too long a time in contact with the leaves and interfere with their function. Those oils used in the manufacture of miscible oils as well as the petroleum fuel oil, distillate oil, and the paraffine oils are much less volatile than kerosene and consequently just as liable to cause injury when the application is followed by low temperatures. The author has sprayed thousands of trees and known of other thousands sprayed by other people and only one or two instances are known to him that disastrous results

followed. It is well, however, to cease spraying just before a freeze is predicted. It is well known that neither hot sun, nor shade, neither rain nor dry weather existing either during or following the application is influential in causing damage.

As yet no experiments have been conducted to determine the effect of these sprays on the bloom and it is inadvisable to use them during the blooming period.

It has been observed that the use of these oils, including kerosene emulsion, causes dim shadows or faint green blotches to appear on the fruit if sprayed early in the season. These disappear when the fruit colors up in the fall and this has never been considered a serious matter by the author.

MR. H. J. QUAYLE: I agree with Mr. Yothers that the injury may be due to something other than the oil itself. We depend largely on distillate oils in California and they are used at a strength from 6 to 8 per cent on dormant trees. The latest use of oil there is the heavy crude petroleum, 16° to 18°, just as it comes from the wells and is used in the form of an emulsion with soap at a strength as high as 15 per cent. This seems to be the only thing that will control the Italian Pear Scale successfully. Thus far there appears to be no complaint of injury even with the heavy crude petroleum.

MR. H. A. GOSSARD: A number of years ago I conducted some small experiments with oils, obtaining the same results as stated by Dr. Felt. Trees treated in the fall had some of the fruit buds killed, while no injury was done by spring applications. The manufacturers of the oil were quite perplexed and skeptical concerning my conclusions and went to considerable trouble to determine where the trouble lay. They took samples of the water used for diluting the oil and reported that they found considerable sulfur in it. They thought this was the explanation of the adverse result. Referring to spraying mixtures, I prefer to recommend the preparation that is nearest to "fool-proof" of any that I know. If I am writing to an experienced horticulturist, whom I know to be an intelligent sprayer, I use my best judgment in giving a prescription, but when making general recommendations for publication or when writing to strangers, I always want to name the nearest to a "fool-proof" remedy that I can. For this reason I prefer to recommend home-made lime-sulfur solution where practicable before the oils or the commercial mixtures.

MR. T. B. SYMONS: In the case of peach lecanium the lime-sulfur will not phase it. We have to recommend the use of an oil mixture, but we state that the application should be made as late in the spring as possible.

PRESIDENT W. D. HUNTER: The chairman suggests that it is getting rather late. Is there a motion for adjournment?

Adjournment.

Morning session, Friday, January 3d, 10 a. m.

PRESIDENT W. D. HUNTER: The first paper is by Mr. W. B. Hungerford, on "The Success of a Two-Spray Calendar in a Kansas Orchard."

THE SUCCESS OF A TWO-SPRAY CALENDAR IN A KANSAS ORCHARD

By HERBERT B. HUNGERFORD, *Instructor in Entomology, University of Kansas*

This paper is given as a report of our spraying experiments in a Kansas orchard for the past season.

The purpose of these experiments was not to base the results on the fruit at picking time but to base them upon the entire history of all fruit set, from blossom time to maturity (and then to compare these results with those based upon counts made at picking time), in order to determine as accurately as possible the efficiency of our spraying methods.

The orchard problem in Kansas is not a simple one. Some sections of the state are infested with apple scab, others are free from that disease but are badly blotched. In some orchards curculio is doing serious injury to the fruit while others seem to be free from it.

We have been trying to get our apple growers to see that the only way in which they can expect to get the best results from spraying is for them to know what they are spraying for. In other words, that each man must diagnose the case of his orchard and then proceed to administer the dose. It is certain, however, that no one in Kansas will make a mistake in considering that his trees are suffering from a chronic case of codling moth and treating for that.

The managers of the larger orchards have found that it does pay to spray but many of the farmers having but small tracts of from five to ten acres have been skeptical.

It was to convince these skeptical ones, as well as to test out certain ideas of the department regarding spraying, that experimental orchard work was undertaken. An orchard of about ten acres, of from 15 to 18-year-old trees, located a couple of miles from the university was leased for a period of years. This orchard had been uncared for and had never produced a crop of marketable fruit. The department having had it under observation for some time, knew its ailments but obtained possession of it too late last year for the control of codling moth and curculio.

There were four things to be treated in this orchard: codling moth, curculio, blotch and bitter-rot.

When the petals were a little more than half fallen a spray was applied for codling moth. The earliest blooming varieties, Duchess of Oldenburg and Transparent were treated first and so on down the line. Each tree was sprayed at the right time, and sprayed as if it were not intended to be sprayed again. A little more than six gallons of spray were applied to each tree, leaving it dripping. The solution used was lime-sulphur and lead arsenate. It was applied with a drive spray nozzle with a pressure of from 180 to 280 pounds. The spray tank held 200 gallons and could be sprayed out in fifty minutes, but the difficulties of obtaining water made the job of spraying last a week.

About ten days later the trees were sprayed again, this time with a mist spray nozzle. The Missouri Pippins, Bens and Ganos were sprayed with Bordeaux and arsenate of lead, the other varieties with lime-sulphur and arsenate of lead.

The first of July the Pippins, Bens and Ganos were again sprayed with Bordeaux and arsenate of lead.

Within a radius of a half mile of the experimental orchard there were two or three unsprayed orchards and on the north end of the experimental orchard a block of trees was left unsprayed as check.

Certain average trees in the unsprayed orchards and in the experimental block were tagged while in bloom and counts made of all drops throughout the season, together with a tabulated report of the ailments of each drop. In all 81,457 apples were counted, tabulated and the results placed on a large chart. From this chart the tables herewith presented were made.

The Missouri Pippins, Bens and Ganos were given two sprayings with Bordeaux to control the blotch and bitter-rot of which there had been a heavy infestation in the past. As a result, there was no blotch whatever on the Ganos and Bens, and probably not over a score of apples affected with it on the twenty-eight Pippin trees,—a fact that it was difficult for us to believe. In a neighboring orchard, where a number of sprays had been but poorly applied, the blotch made unmarketable nearly every apple of the blotch susceptible varieties, namely, the Pippin, Winter Banana, Maidenblush, Lady-sweet, and several others.

The relation of the spraying to crop production is shown in chart number 1. Here there is recorded an historical summary of all fruit set. It may be noted that the drop in May was very large. This was what we have chosen to call the thinning drop. It was not possible to find any reason for most of these drops. In July there were many

SPRAY RELATION TO CROP PRODUCTION

CHART NO. 1: 81,457 APPLES COUNTED

	Variety	Total No. set	May drops	July drops	Aug. drops	Sept. drops	Total No. drops	Per cent dropped	No. picked	Per cent picked
UNSPRAYED	Gano	4,069	1,241	333	386	468	2,430	41.70	1,639	58.30
	Jonathan	4,966	417	547	564	1,612	3,140	60.35	1,826	39.65
	Winesap	6,401	630	249	487	1,285	2,651	35.45	3,850	64.55
	M. B. Twig	1,942	605	307	364	457	1,733	84.40	209	14.60
SPRAYED TWICE	Jonathan, 2 trees	4,436	697	32	226	1,108	2,063	36.50	2,363	63.50
	M. B. Twig, 1 tree	5,656	2,678	19	61	83	2,841	5.47	2,814	94.53
	Winesap, 2 trees	8,741	989	14	294	236	1,433	5.73	7,287	94.27
	Grimes G., 2 trees	15,681	4,856	63	420	541	5,880	9.47	9 791	90.53
SPRAYED THREE TIMES	Ben Davis, 2 trees	6,627	1,533	66	419	313	2,331	15.80	5,296	84.20
	Mo. Pippin, 2 trees	14,007	1,650	35	231	354	2,270	5.02	11,737	94.98
	Gano, 2 trees	8,931	1,889	97	400	404	3,690	25.28	6,366	74.72

more drops in the unsprayed block than in the sprayed. This was true throughout the remainder of the season, for it is to be noted that the numbers in the sprayed blocks represent the drops from two trees while in the unsprayed block the fall is from single trees. In the September drop the Jonathan of both sprayed and unsprayed ran high. This was attributed, the country over, to the weather conditions. In our country, however, the Jonathan seems to have the bad habit of letting fall its partly ripened fruit. Spraying tends to check this, for while the unsprayed tree dropped 1,612 apples, the sprayed only dropped 554. In the case of the Black Twig 84.4 per cent of the fruit that started out to grow fell by the way, while only 5.4 per cent of the sprayed fruit dropped

EFFICIENCY OF SPRAYING IN THE PRODUCTION OF SOUND FRUIT

CHART NO. 2: 81,457 APPLES COUNTED

	Total number of apples set	Thinning drop—May	Total number of unsound apples	Total number of sound apples	Per cent of sound apples
UNSPRAYED Orchard, 4 trees counted	17,378	2,893*	12,369	2,116	14 60
SPRAYED Orchard, 2 sprays, 7 trees counted	34,514	9,220*	1,592	23,702	93.81
SPRAYED Orchard, 3 sprays, 6 trees counted	29,565	4,847*	1,210	23,508	95 10

* Cause of drop undetermined and therefore not figured in the percentage of sound apples.

If we compare the efficiency of spraying in the production of sound fruit (chart number 2), we see that there was but 1.29 per cent difference between the twice sprayed and the thrice sprayed blocks. We must take into consideration, however, that the varieties differ and that the block sprayed three times contained blotch susceptible varieties, and the hardest apples to keep clean, grown in our state.

COMPARISON OF CODLING MOTH INFESTATION IN SPRAYED AND UNSPRAYED ORCHARDS

CHART NO. 3: 81,457 APPLES COUNTED

	Variety	Per cent Cod. Moth July drops	Per cent Cod. Moth August drops	Per cent Cod. Moth Sept. drops	Per cent Cod. Moth picked apples	Total per cent Cod. Moth of all apples set
UNSPRAYED	Gano	57.30	52.52	78.9	37.2	44.4
	Jonathan	92.15	74.35	74.6	49.5	56.3
	Winesap	92.00	52.30	76.3	19.2	32.8
	Black twig	82.20	89.50	95.4	66.6	58.2
SPRAYED TWICE	Jonathan, 2 trees	21.85	4.42	1.44	.88	2.02
1, as petals fell, with L. S. and Ars. L.	Black Twig, 1 tree	10.53	11.47	15.66	.74	.76
2, 10 days later, L. S. and Ars. L.	Winesap, 2 trees	50.00	11.62	11.42	1.20	2.98
	Grimes G., 2 trees	20.31	6.66	9.79	.64	1.47
SPRAYED THREE TIMES						
1, as petals fell, with L. S. and Ars. L.	Ben Davis, 2 trees	7.58	2.62	6.07	2.53	2.33
2, 10 days later, Bd. and Ars. L.	Pippin, 2 trees	17.15	6.46	7.34	.80	1.03
3, July 1, Bd. and Ars. L.	Gano, 2 trees	11.33	3.00	5.45	2.20	2.04

In a comparison of codling moth infestation in sprayed and unsprayed orchards (chart number 3), we find that the per cent of codling moth infestation of dropped apples was much heavier in the unsprayed orchard than in the sprayed, and when we come to compare the percentage of infestation in picked apples, we discover that in the unsprayed blocks 19.2 to 49.5 of the fruit was wormy, while in the twice sprayed block three out of the four varieties produced less than one per cent of wormy fruit. In the block sprayed three times the infestation ran just a little higher.

If there were time it would be interesting to make a comparison of the varieties of apple in regard to their ability to withstand the infestation and still remain on the trees; for a comparison of the percentages of the infestation of picked apples and the percentages of

infestation based on all apples set would seem to indicate that some varieties do have a greater tendency to drop as a result of codling injury than others. This may be used to determine the relation of other insects to crop production, for while the per cent of codling moth infestation of all apples set runs higher than the one based on the apples picked, the reverse is true of curculio.

In the April JOURNAL Doctor Ball states "that records founded upon picked fruit only are untrustworthy and practically valueless for scientific purposes" and "that in all tests of efficiency absolutely accurate accounts should be kept of every fruit that sets[1] on the tree."

By placing the two percentage columns together as they are in chart 3 we see that there is considerable difference in the individual percentages and it is obvious that the one on the right more nearly presents the efficiency of our spraying operations.

COMPARISON OF CURCULIO INFESTATION OF SPRAYED AND UNSPRAYED ORCHARDS

CHART NO. 4: 81,457 APPLES COUNTED

	Variety	Per cent curculio August drops	Per cent curculio Sept. drops	Per cent curculio picked apples	Total per cent curculio apples set
UNSPRAYED	Gano, 1 tree	19.60	18.45	29.22	13.70
	Jonathan, 1 tree	15.13	21.85	40.52	22.23
	Winesap, 1 tree	23.66	22.66	48.54	33.92
	Black Twig, 1 tree	2.47	10.50	17.19	4.28
SPRAYED TWICE	Jonathan, 2 trees	10.60	.36	6.06	3.50
1, as petals fell, L.S., Ar. L.	Black Twig, 1 tree	4.92	12.04	2.83	1.64
2, 10 days later, L. S. and	Winesap, 2 trees	6.52	2.52	3.81	3.40
Ars. L.	Grimes G., 2 trees	10.48	8.50	1.78	1.69
SPRAYED THREE TIMES					
1, as petals fell, L.S., Ar.L.	Ben Davis, 2 trees	5.00	7.67	2.36	2.53
2, 10 days later, Bd. M. and	Pippin, 2 trees	5.18	6.22	1.87	1.84
Ars. L.	Gano, 2 trees	8.00	4.21	3.57	2.52
3, July 1, Bd. M. and Ar. L.					

Comparing the sprayed and unsprayed trees with reference to curculio infestation (Chart No. 4) we see that in the unsprayed orchard the infestation of the picked apples ranged from 17 per cent in the case of the Black Twig to 48.5 per cent in the Winesaps, while in the block sprayed twice the Black Twig showed an infestation of but 2.83 per

[1] In connection with the determination of efficiency in spraying operations it might be of interest to note that Dr. S. A. Forbes as early as 1885 based the results of his spraying experiments upon a history of all the fruit set. Dr. Forbes is, the writer believes, the first to apply this method to insecticide work.

cent and the Winesap, but 3.81 per cent. The Jonathan tree in the unsprayed block had more than 40 per cent of its fruit damaged while the one sprayed twice was injured to the extent of only 6 per cent. The unsprayed Gano showed an infestation of nearly 30 per cent, the one sprayed three times, less than 4 per cent.

This again shows the inaccuracies that might result from basing spraying results upon the fruit at picking time, for the actual control was not as the above statement would indicate. For instance, the Black Twig in the unsprayed block had less than 4 times the infestation of the sprayed block, while the former figure gave an apparent control of 1 to 6. The Winesap results varied from an apparent ratio of 1 to 13 to an actual of 1 to 10.

An examination of Chart No. 4 fails to show any reason for the third spray for curculio. It is worthy of note in this connection, that no early sprayings were made for this in these experimental blocks, the control being due to those applied for the Codling Moth.

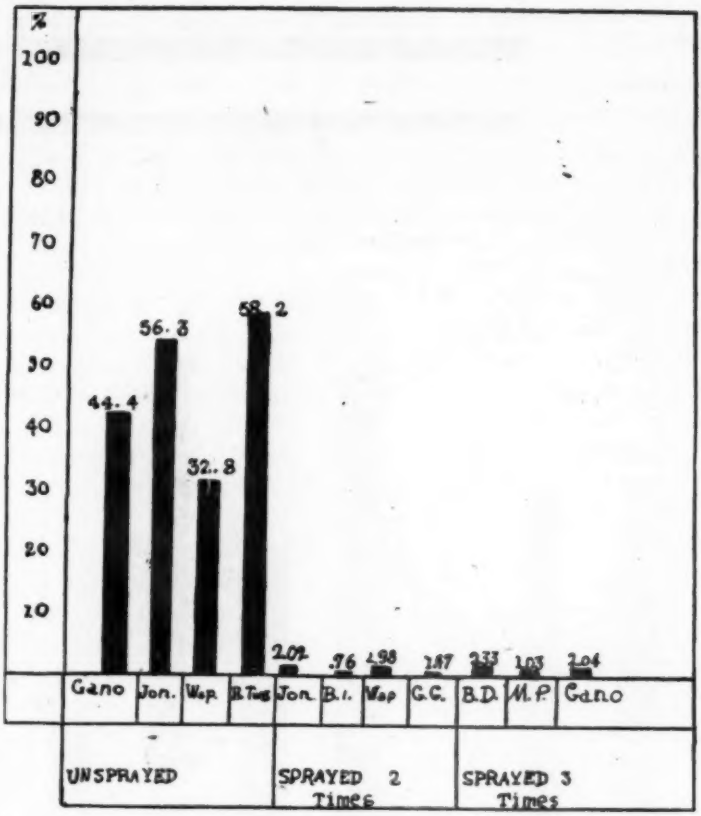
COMPARISON OF BITTER ROT INFESTATION IN SPRAYED AND UNSPRAYED ORCHARDS

CHART NO. 5: 81,457 APPLES COUNTED

	Variety	Per cent B. R. July drops	Per cent B. R. August drops	Per cent B. R. September drops	Per cent B. R. picked apples	Total per cent B. R. apples set
UNSPRAYED						
	Gano	4.77	4.64	22.66	9.70	7.40
	Jonathan	.91	2.13	13.53	6.96	8.14
	Winesap	.00	6.57	27.07	11.16	11.10
	Black Twig	.30	3.85	15.56	3.35	4.78
SPRAYED TWICE						
1, L. S. and Ar. L., as petals fell	Jonathan, 2 trees	.00	3.61	.18	.29	.67
2, L. S. and Ars. L., 10 days later	Black Twig, 1 tree	.00	4.92	6.02	.00	.14
	Winesap, 2 trees	.00	6.05	.00	.41	.77
	Gr. Golden, 2 trees	1.58	3.09	4.25	.06	.40
SPRAYED THREE TIMES						
1, L. S. and Ars. L. as petals fell.	Ben Davis, 2 trees	.00	3.12	12.02	1.32	1.82
2, Bd. and Ars., 10 days later.	Pippin, 2 trees	.00	3.54	.28	.29	.32
3, Bd. and Ars. L., July 1	Gano, 2 trees	.00	9.00	4.95	.83	1.20

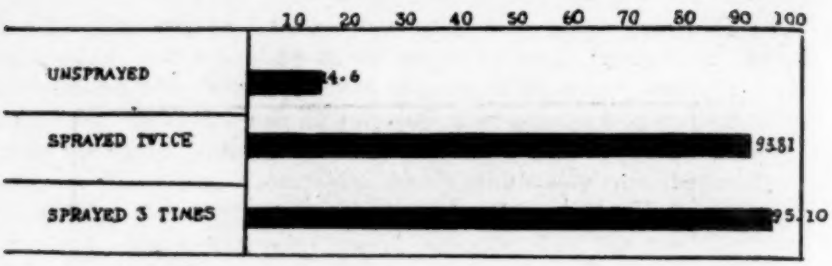
The experimental orchard had been badly infected with bitter rot and though the present season was considered a good bitter rot season, it is interesting to note that it was a negligible quantity in the twice sprayed orchards though running from 4.7 per cent to 11 per cent in unsprayed blocks.

The following charts show graphically what has been above presented.



SHOWING CODLING MOTH INFESTATION OF SPRAYED AND UNSPRAYED TREES
Chart No. 6

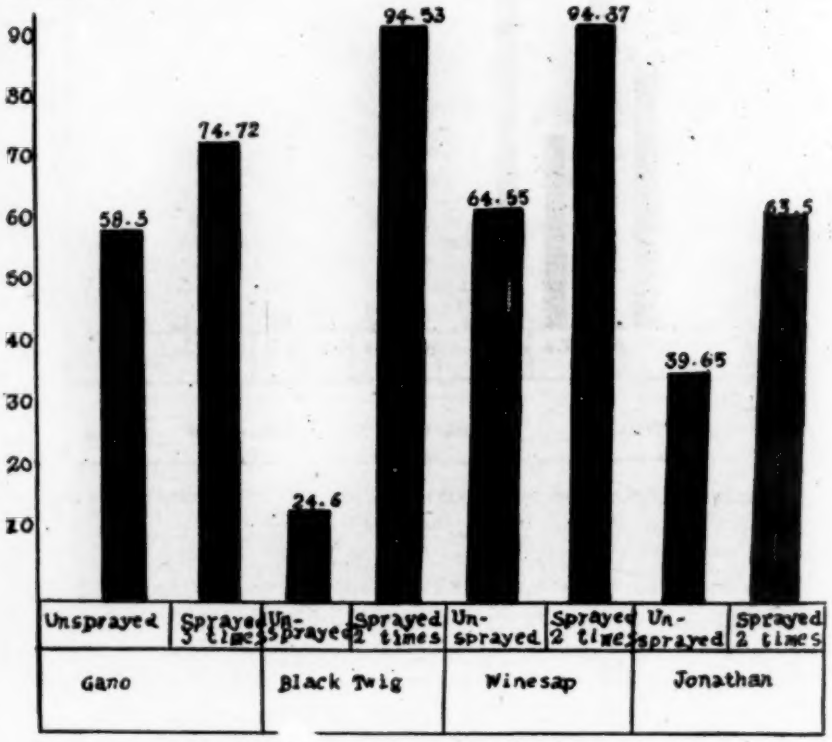
In Chart No. 6 the columns represent the codling moth infection. The high ones on the left show the infection in the unsprayed orchard, the ones on the right, in the sprayed blocks. As might be expected there is no marked difference between the two and three spray blocks.



EFFICIENCY OF SPRAYING IN THE PRODUCTION OF SOUND FRUIT

Chart No. 7: Showing graphically per cent of sound fruit on sprayed and unsprayed blocks (Columns represent sound fruit)

The columns in Chart No. 7 represent the per cent of sound fruit produced.



SPRAY RELATION TO CROP PRODUCTION

Chart No. 8: Showing graphically the per cent of all apples set, which were on the trees at picking time, regardless of injury on sprayed and unsprayed trees of the same variety

From Chart No. 8 we see that the sprayed orchard produced from one-third more to seven times as much fruit as the unsprayed.

Inasmuch as spraying results have generally been based upon one or the other of the ratios given we thought that it might be of interest in recording our results to present both percentages. We have found that the results would be quite different in some cases. Both figures, however, show that the insect pests of this orchard were controlled by two sprays, and though no conclusions could be drawn from one orchard or from one season's work, studies made in many orchards scattered over the southern portion of the state lead us to believe that in the majority of cases two sprays are sufficient for the control of such insect pests as we have in Kansas.

As one who has looked at the problem from the commercial side we would say that the entomologist should recommend as few sprays as possible for the best returns, for the long spray calendar usually recommended has a tendency to discourage many of our small orchard holders from attempting to spray at all. But in the last analysis the recommendations should be specific rather than general.

PRESIDENT W. D. HUNTER: This paper is before you for discussion.

A MEMBER: What time during the year did you spray for "bitter rot"?

MR. W. B. HUNGERFORD: We only made one spray solely for "blotch" and none for "bitter rot alone."

MR. T. B. SYMONS: Is Bordeaux better than lime-sulfur?

MR. W. B. HUNGERFORD: Yes, but there is a difference in seasons. Last season we had some injury from lime-sulfur.

PRESIDENT W. D. HUNTER: We will proceed with the next paper by Dr. Felt, on "The Codling Moth and One Spraying in the Hudson Valley."

THE CODLING MOTH AND ONE SPRAYING IN THE HUDSON VALLEY

(Abstract)

By E. P. FELT, *Albany, N. Y.*

Spraying experiments for the codling moth have been conducted during the past four seasons in Hudson valley orchards. In each instance the work was planned along practical lines so far as possible and special pains taken to secure only fairly representative trees in orchards kept in a good horticultural condition. Invariably the spraying outfit and the men on the place were employed, the entomologist contenting himself simply with explaining his methods and insisting upon reasonable thoroughness in treatment. The experiments were conducted in four well separated localities, while the

trees selected were of the standard varieties, being Baldwins, Greenings, Northern Spy and Ben Davis. The diversity of season, location, equipment and men, and the different varieties used for the tests prevent these experiments being classed as local or exceptional. The spraying was invariably given as soon as possible after the dropping of the petals, special pains being taken to throw the poison down upon the upturned ends of the young apples, though during the last three years it was not deemed advisable to attempt to force the spray into the lower calyx cavity.

The results obtained during this period are shown in the following tabulation.

SUMMARY OF RETURNS FROM CHECK OR UNSPRAYED TREES

Plot	Series	Year	Total fruit	Clean Fruit		Wormy Fruit					
				Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Per cent end wormy
Check ..	1	1909	3,251	2,366	72.73	885	27.27	312	302	271	
Check ..	2	1909	7,015	5,127	73.08	1,888	26.92	674	630	584	
Check ..	1	1910	711	202	28.41	509	71.59	186	240	82	
Check ..	2	1910	2,000	593	29.65	1,407	70.35	700	324	383	
Check ..	1	1911	5,337	4,540	85.06	797	14.94	379	166	252	
Check ..	2	1911	14,670	9,860	67.21	4,810	32.79	2,048	949	1,813	
Check ..	2	1912	878	342	39.95	536	61.05	212	238	86	
Grand total			33,868	23,030	67.99	10,832	32.01	4,511	2,849	3,471	21.73

SUMMARY OF FOUR YEARS WORK WITH ONE SPRAY FOR THE CODLING MOTH

Plot	Series	Year	Total Fruit	Clean Fruit		Wormy Fruit					
				Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Per cent end wormy
1	1	1909	30,177	29,818	98.81	359	1.19	33	18	308	
4	1	1909	20,313	20,017	98.55	296	1.45	31	6	259	
1	2	1909	21,264	21,042	98.96	222	1.04	23	18	181	
4	2	1909	9,852	9,683	98.27	169	1.73	19	13	137	
7	2	1909	19,091	18,617	97.52	474	2.48	51	32	391	
1	1	1910	1,839	1,664	90.48	175	9.52	16	21	138	
1	2	1910	8,135	6,677	82.08	1,458	17.92	160	27	1,271	
1	1	1911	16,638	16,515	99.26	123	.74	19	12	92	
1	2	1911	20,802	20,401	98.07	401	1.93	28	14	359	
1	1	1912	11,136	10,833	97.26	305	2.74	14	16	275	
2	2	1912	10,029	9,898	98.69	131	1.31	13	13	105	
Grand total			169,278	165,165	97.56	4,113	2.44	407	190	3,516	.353

It will be seen that the check plots during this four-year period gave an average percentage of sound fruit amounting to 67.99, the yield in individual plots varying from 28.41 to 85.06 per cent. The average percentage of end wormy fruit for these plots is 21.73, a marked contrast to what was obtained from the sprayed trees. The returns from these check trees may be briefly summarized as follows: Approximately one third of the fruit was wormy and nearly two thirds of the wormy apples were entered at the end or end wormy.

The above data show that one spraying during this period produced from 82.08 to 99.26 per cent of sound fruit or an average of 97.56 per cent for the four years when comparisons are made between an equal number of plots in each year. In explanation it should be stated that the figures for several plots in 1909 were omitted in calculating the averages simply to give more nearly equivalent values to the returns obtained for the four year period. Attention should be called to the relatively low percentages of 1910, a season remarkable for the unusual destructiveness of the second brood and one presenting infrequent conditions which were further accentuated by the small yield of that year. Excluding the data for that season, the lowest percentage of sound fruit obtained from one spraying was 97.52. It is worthy of note that only a little over one third of 1 per cent (.353 per cent) of the wormy apples were end wormy, a striking contrast to the 21.73 per cent end wormy on the check or unsprayed trees.

A study of the above data justifies the conclusion for the Hudson valley at least, that in normal seasons when the crop is abundant or fairly so, one thorough early spraying within a week or ten days after the blossoms fall and preferably early during that period, should result in securing from 95 to 98 per cent of sound fruit. Our data show that the benefit resulting from two later sprayings is comparatively small so far as controlling the codling moth is concerned though ample to meet the cost of the posion and, in many instances, probably the expense of treatment.

PRESIDENT W. D. HUNTER: This paper, which has well summarized an important line of work, is now before you for discussion.

MR. W. E. BRITTON: Whether we use one or more sprayings against the codling moth will depend upon local conditions. In Connecticut there are several neglected orchards where 80 per cent of the unsprayed fruit shows codling moth injury. In other orchards which have been sprayed for several years there may be not more than 10 per cent of wormy unsprayed fruit. Last fall I saw a tract of land in Connecticut, purchased twenty years ago as an abandoned farm. It was rough and grown up to bushes. Fifteen years ago some of the land was

plowed and planted to apple trees, chiefly Baldwins and Greenings. The past year these trees were given one spraying with lead arsenate (no fungicide) and I never saw a finer lot of fruit.

MR. T. B. SYMONS: I would like to ask Dr. Felt if he used any fungicides.

MR. E. P. FELT: Yes, but we did not pay any attention to it. I should not be understood that one spray is always sufficient. I believe that if we are working to get results with one spray it is necessary to keep the orchard in a good condition from a horticultural standpoint. After one or two years, and if there were no local disturbing factors I should expect to get 95 per cent worm free fruit.

MR. H. A. GOSSARD: We have tested the one spray method a few times in Ohio. One of our orchardists tried it and he reported that his results were entirely satisfactory. Another man equally thorough in his work has tried the same thing two or three times and has failed, so there must be some local disturbing conditions. We have several orchards which have been sprayed under the supervision of the Station for seven or eight successive seasons. One man sprays twice; once immediately after bloom and again about a week or ten days later and usually has from 98 per cent to 99 per cent of sound fruit. Another orchardist with whom we coöperate, whose trees are more open and who does not use quite so much liquid as the former, finds it almost necessary to give two sprays, one after the bloom and one about the last of July. Some have both the lesser apple worm and the codling moth to fight. It seems to be a matter of judgment depending on local conditions as to whether or not a second application can be safely omitted.

MR. S. J. HUNTER: We applied one spray last year when the blossoms were about one-half fallen and a second after the calyx cup closed on our wine saps and at picking time 98 per cent were sound.

MR. T. J. HEADLEE: I may be repeating what someone else has said; but if that be so it will only serve to emphasize what our experience has indicated as a very important point. The orchardist is all too ready to grasp at any suggestion emanating from reliable sources which promises to reduce the amount of work necessary to produce a crop. In our work in Kansas orchards we have invariably found both codling moth and curculio, and in no case in the course of two years extensive tests have we found the one spraying sufficient and satisfactory. In view of these facts we believe that the advocacy of a single spraying for the control of insect and fungous enemies, in Kansas orchards at least, to be inimical to the best interest of the fruit grower.

MR. E. P. FELT: I sympathize with the speaker, and yet I find myself confronted by facts. I find myself talking to men who have made one spray for the codling moth and got the results. I believe that we,

as scientific men, must recognize the possibility of the one spray and I do not see the slightest danger in calling attention to it. Professor Quaintance reports in spraying against codling moth and curculio, that there was not much difference between trees that received one application and those which received three, and sometimes five applications. In the Hudson Valley we can do more to emphasize the importance of one spray, with a warning that at times it may not be sufficient, rather than to urge several treatments. I may say further that I have yet to find very serious insect injury from various leaf feeders in orchards that have systematically received one spray annually.

MR. P. J. PARROTT: Is it not a fact that apple scab is not as injurious along the high lands of the Hudson River as in some portions of western New York?

MR. E. P. FELT: These results do not necessarily apply to the western part of the State.

PRESIDENT W. D. HUNTER: The next paper is by Mr. P. J. Parrott entitled, "Notes on Three Tree Crickets."

NOTES ON TREE CRICKETS

P. J. PARROTT and B. B. FULTON

Recent years have been very prolific in comprehensive economic entomological treatises of a general nature. As these have come into our possession we were invariably prompted by reason of our interest in tree crickets to turn early to the pages dealing with them. A perusal of the subject-matter has impressed us either with the prevailing misconceptions regarding their habits or with an apparent lack of certainty which has led to indefiniteness of statement. The accompanying brief notes are here given to call attention in a way that we have not been able to do heretofore to certain habits of *Oecanthus niveus* De Geer, *O. nigricornis* Walk, and *O. quadripunctatus* Beut., which are the most common species in plantings of small and tree fruits in New York.

The species *niveus*, popularly known as the snowy tree-cricket, deposits its eggs singly, which habit distinguishes it from the foregoing associated forms. In the region about Geneva oviposition is most abundant in apple, plum, cherry and elm, and to a much less extent in peach, walnut, wild crab, hawthorn, witch hazel, chestnut, red oak, maple, butternut, lilac and raspberry. With old trees the eggs may be found principally in the thickened bark about the bases of fruit spurs or branches or in the bark of the larger branches, while with small trees they also occur in the bark of the trunks. In spite of the large numbers of the adults which may be observed in raspberry plantations, other

plants, as enumerated above, seem to be much more preferred for purposes of oviposition. With this fruit the eggs are inserted singly at the sides of the dormant buds in the fleshy region at the axils of the leaves.

This species derives its economic importance largely from its injurious work on apple trees, especially in neglected plantings, which sometimes are quite badly scarred as a result of the wounds caused by the oviposition punctures. The penetration of the tissues by the ovipositor may apparently be also attended by infection with some unknown fungus or bacterial organism, which not infrequently forms a canker, indistinguishable in its external appearance and effects from the New York apple-tree canker (*Sphaeropsis malorum* Pk.) or the blight canker of apple trees (*Bacillus amylovorus* [Burr] de Toni). The woolly aphis may also establish itself in wounds made by this cricket and thus aggravate the primary injuries.

The species *nigricornis* differs in its oviposition habits from *niveus* by depositing its eggs in long rows. It prefers for the reception of its eggs raspberry, blackberry, horseweed (*Erigeron canadensis* L.) and goldenrod, *Solidago* spp. Oviposition occurs to a less extent in twigs of willow, elder, maple, elm, sumac, grape and peach. This species has been discussed by many writers under the name of *niveus*, and judging from the accompanying illustration in their accounts it would appear that *nigricornis* deposits its eggs in a great many plants in addition to the foregoing, as currant, artichoke (*Helianthus* spp.), *Ambrosia* spp., cottonwood, box elder, cherry, dogwood, black locust, sycamore, ash, honey locust, and catalpa. This cricket is sometimes quite destructive in raspberry plantings as the wound made by the deposition of so many eggs may cause the death of the terminal growth of the shoot or loss of fruit from the breaking off of the cane at the point of injury.

The species *quadripunctatus* may be observed occasionally in raspberry plantings in company with *niveus* and *nigricornis*. It is, however, of no economic importance. It oviposits in weeds, principally

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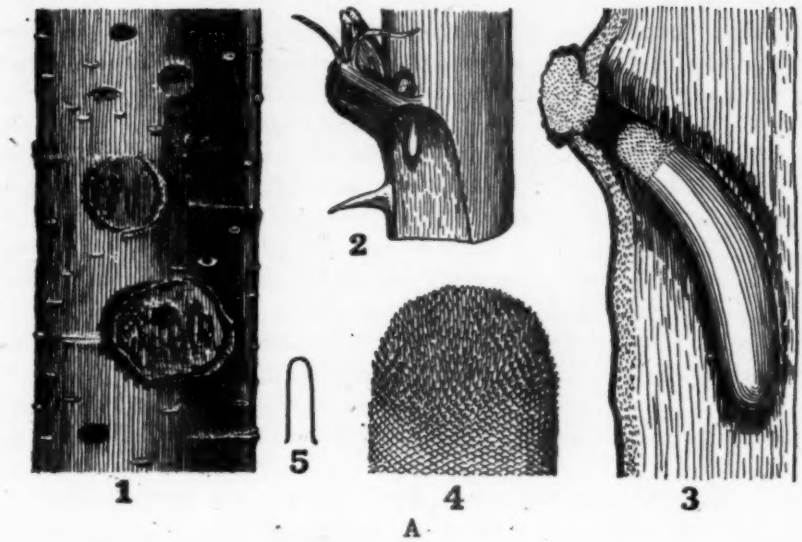
OECANTHUS NIVEUS, A.—1, Apple wood showing egg punctures and diseased areas, x1½; 2, Egg at base of petiole in raspberry, showing normal oviposition in this plant, x2½; 3, Egg, showing its position in apple bark, x15; 4, Egg cap showing spicules, x50; 5, Spicule showing characteristic outline, x500.

OECANTHUS NIGRICORNIS, B.—1, Row of egg punctures in raspberry, x1½; 2, Longitudinal section of the same, x3; 3, Egg, x15; 4, The egg cap, x50; 5, A single spicule of the cap, showing characteristic outline, x500.

OECANTHUS QUADRIPUNCTATUS, C.—1, Egg punctures in wild carrot (*Daucus carota*), x1½; 2, Longitudinal section of the same, x3; 3, Egg, x15; 4, Cap of egg, x50; 5, A spicule of egg cap, showing characteristic outline, x500.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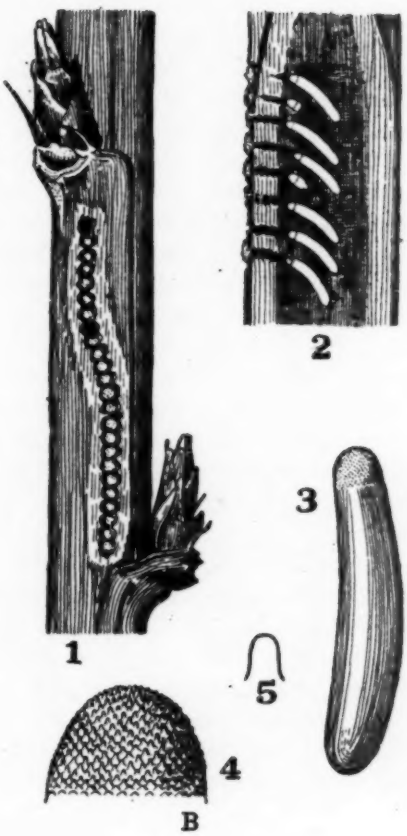
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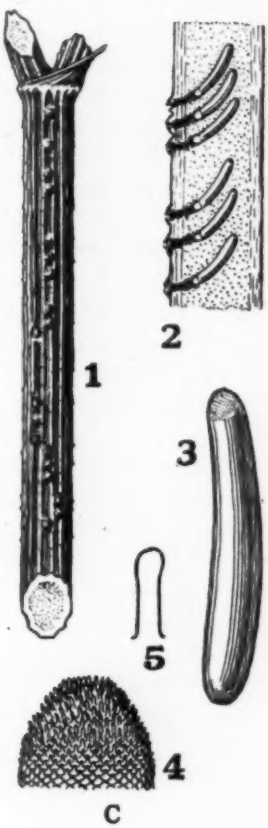
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the wild carrot (*Daucus carota* L.), goldenrod and aster. Like *nigricornis* the eggs are deposited in rows, but the insect seems to prefer stems and stalks of five millimeters or less in which to place them.

PRESIDENT W. D. HUNTER: Any discussion on this paper?

MR. W. E. BRITTON: Which species lays eggs in rows on the peach trees?

MR. P. J. PARROTT: That is *Oecanthus nigricornis*.

A MEMBER: Do you know of a species which lays three or four eggs deposited on either side of a wound?

MR. P. J. PARROTT: This is the work of another species which we hope to study. It is apparently a southern species.

PRESIDENT W. D. HUNTER: The next paper is by Mr. R. L. Webster on, "The Arrangement of the Material for an Entomological Bulletin."

THE ARRANGEMENT OF MATERIAL IN AN ENTOMOLOGICAL BULLETIN

By R. L. WEBSTER

Several years ago, when preparing an outline for a bulletin, it struck me that the usual order of arrangement of matter in entomological bulletins in general was not that demanded by an economic treatment. It seemed to me that it was quite unnecessary to thrust on the farmer and fruit-grower a detailed account of the past history, the synonymy, the stages and the habits of an insect, before giving him a word concerning the control measures; the thing in which, presumably, he is most vitally interested. And I had heard the complaint that "we can't find things in the bulletins," for which there must have been a reason.

With this idea in mind I attempted to work out an arrangement by which an insect could be treated of in a more logical manner, from an economic standpoint; an order that would throw the popular treatment and the control measures in the fore part of the bulletin, where they may be seen easily, and place all the more technical matter in the latter part.

Most of the entomological bulletins published in this country have been concerned with individual species of insects although bulletins which consider insects in economic or systematic groups have not been uncommon. Of these last I am not so directly concerned in this paper, which will refer, for the most part, to a bulletin considering a single insect; in other words, to a monographic bulletin.

The usual order in a bulletin of this kind is an historical one, which first treats of the insect's past history, its destructiveness, and the

synonymy, which is followed by an account of the generations and the stages, and which concludes with a discussion of the natural enemies and the control measures. In using such an arrangement the entomologists in this country seem to have followed the custom of Fitch, Riley and Lintner. Both Riley and Fitch used this general arrangement to a considerable extent but it was most used by Lintner, whose entomological articles were almost entirely written up in this historical order.

Now this is a logical order from the standpoint of pure science. It is perfectly intelligible to the entomologist and in consequence it seems proper to use. It is quite natural to lead up to the control measures for an insect after a full discussion of its habits and life history, upon which the control measures depend.

But an entomologist should write not only for his fellow-entomologists, but for all his readers, and especially for the man to whom his writings ought to be of most use, the man whose crops are damaged by insect pests. Our bulletins are sent to a very large number of people, of whom only a very few know much about insects. The whole mailing list at the Iowa Experiment Station amounts to something like 20,000, of which not more than 400 at the most are entomologists. So it seems to me that it is my business to write my bulletins, if I am able to do it, for the whole 20,000, rather than only for the 400.

You cannot expect the average farmer to become an entomologist; the best educated farmer will have difficulty in wading through an entomological bulletin containing any great amount of technical matter. It appears to me that it is the place of an entomologist to become a farmer, so far as he is able, when he attempts to write an article which he expects the farmer to understand. It certainly is not beneath his dignity to attempt such a thing, in fact it is quite possible that he might become a better entomologist and be more appreciated by those who read his bulletins if he should do something of this kind.

In this connection I may well refer to a portion of the presidential address given before this association in 1893, by Dr. S. A. Forbes. Dr. Forbes said " . . . I am inclined to think that we are very likely to forget, when we prepare our reports, that we are writing largely for men to whom entomology is a perplexing, obscure and displeasing subject, of which they know little or nothing, and especially nothing good; but on the other hand, they are frequently experts in crop inspection, far quicker, as a rule, to observe injuries to their crops than we are, and more likely to discriminate them nicely. If we had always borne this fact in mind, I think that our economic articles would usually have taken quite a different form. The crop injury, and

its characteristic appearances would have led in our discussions, and remedial and preventive measures would have followed thereupon as immediately as practicable, the insect itself being brought in, if at all, in a strictly subordinate way, as an aid to the recognition and classification of the injury, and as a guide to the selection of an economic method."

In the discussion of teaching methods of entomology, at the Minneapolis meeting of this association, this same point was brought out. That teaching which reasoned from the injury to the insect was more effective than with that method reversed, was the meat of the discussion. In other words the matter was better considered from effect to cause, rather than from cause to effect, as Prof. J. G. Sanders then put it.

Where an economic group of insects has been concerned, the consideration of the whole subject according to the injury to the plant often has been used. Saunder's "Insects Injurious to Fruits" and Forbes monograph of corn insects (18th and 23d reports) will remain classic examples of this kind. Insects are there considered as attacking leaves, or branches, or roots, etc., as the case may be, the order of their consideration depending on an economic, rather than on a systematic relationship.

Certainly it is the injury to a crop that the farmer notices before anything else. Many a time he does not see the insect which has caused an injury, sometimes he sees the wrong insect, but he does see the damage. Then it is the damage of an insect to a plant that is the logical thing with which to start an entomological article of economic importance. Now it seems to me that, having attracted the reader by a description of the injury, something with which he may be more or less acquainted, his attention may be held for a few succeeding paragraphs, in which the insect may be very briefly described, and the life history in its essential details given. At this point only the bare essentials need be given, just enough to give a clear idea, nothing more. The weak points in the life history, where the insect may be reached by control measures, should be brought out quite distinctly at this point. This part of the text, also, is the place for illustrations of injury, and the insect as well, which tell more than pages of text.

Now the control measures may be discussed, for that is the point we have been trying to reach all the while. This is likely to be more in detail, if much experimental work has been done, but there is no reason why it cannot be put in popular language. In concluding the discussion of the control measures definite steps may be advised for the insect. This completes the popular portion of the bulletin, and so far the reader may go without encountering a single technical word,

unless it be the words larva, pupa or adult, and the meaning of these the average reader ought to know. I think it is best to explain these common terms the first time they are used in the text, afterward using them without further explanation. If a popular edition of the bulletin is to be issued, the first part of the regular edition, including the discussion of the control measures, may be printed as a separate bulletin.

Having concluded that part relating to the measures for control, we are now ready for the more technical treatment, such as the past history, the synonymy, the stages in detail and the natural enemies of the insect. In this part of the bulletin we are writing more for entomologists; few others will pay very much attention to the technical portion. Order is less important here, since the entomologist will look for those things in which he is interested, and on account of his training he is able to pick out more easily the essential points. But we must have some order, and the chronological order such as indicated appears to serve as well as any other. The position for the bibliography is, of course, at the end.

Summaries are frequently placed at the end of a bulletin; a rather natural position. Personally, however, I like to see them at the front, where they may be encountered as soon as a bulletin is opened, and boiled down to a single page, giving the real essentials of the bulletin.

Such an arrangement of material as has been here indicated the writer has been using in entomological bulletins of the Iowa Experiment Station during the past four years and it has proved to be very satisfactory.

In order to bring out the arrangement here considered a little more clearly, there is given below an outline on which a bulletin of this kind may be built up. This refers to a monographic bulletin, concerning one insect.

1. Summary.
2. Recent injury.
3. Appearance of the injury.
4. The insect's appearance (brief descriptions)
5. Time of appearance of the generations (briefly).
6. Control measures.
7. Steps advised.
8. Past history.
9. Destructiveness.
10. Distribution.
11. Food plants.
12. Classification.
13. Life history.
    a. Generations (in detail).
    b. Stages (detailed descriptions).
14. Natural enemies.
15. Bibliography.

It may be seen that the matter is easily divided between the numbers 7 and 8. Before this division is considered only the broader aspects of the problem, after it comes the detailed account.

This arrangement of a bulletin, which I have taken up at some length, is not a change of the matter treated, but only a change in the order. It is an arrangement which may not fit any and every bulletin, but it may be adapted to a great number of them, and especially to those concerning a single insect. This order in a bulletin, based as it is on the economic treatment of an insect, is, it seems to me, an order that is more readable, more interesting and more intelligible to the average farmer or fruit-grower than the order generally followed.

PRESIDENT W. D. HUNTER: This interesting paper is now open for discussion.

MR. F. L. WASHBURN: I think the summary should be at the beginning of the paper so that the farmer on opening the publication can see in a brief way what results have been secured. The summary should be in the beginning or at the end in bold type. We have to consider not only the farmer but also other entomologists who may criticize if we omit the technical part. The latter can be published separate from the economic part.

MR. W. E. BRITTON: I agree with Mr. Webster, and yet there are some of us who are not able to publish as we should like to on account of certain methods having been adopted by the directors of the stations. I think that perhaps the best place for the summary is in the beginning. The back page on the outside is also a good place, where it may be seen without opening the bulletin. Many times the subject matter must determine the form in which it is written. It is perhaps better to put in one place all the most important facts, provided this part is separated so that the farmer can readily see it.

MR. E. P. FELT: I think this subject is one of importance. It is a study in the psychology of presentation. I have been wondering how many men know the actual efficiency of the bulletins sent out from their offices. Sometimes it is just as well to write one paragraph and have it read by 10,000 as to write 10,000 paragraphs and have them read by one. We should use the local press at the time insects are causing damage. I go into many homes and it is only once in a while that I find a man who keeps entomological publications. There are only a few who keep them and I do not know of one man who could place his hands on the desired book. I have been wondering if a group of interested men could make some studies of this and report to us.

PRESIDENT W. D. HUNTER: Dr. Felt has made a suggestion that is

worth our consideration. I would like to ask if he wishes to place it in the form of a motion.

MR. E. P. FELT: I think the information might be useful to some of our men and I move that the chairman appoint a committee of three to investigate the use to which our publications are put and report at the next meeting.

MR. T. B. SYMONS: I believe the press bulletin and such forms of matter that are gotten out from week to week are very useful supplements to the general station bulletins. I second Mr. Felt's motion. I have been wondering if we should not have a press committee whose business it would be to see that our meetings are advertised in a general way throughout the country.

By vote of the Association the motion was carried.

PRESIDENT W. D. HUNTER: The next paper will be by Mr. A. W. Morrill on "Entomological Pioneering in Arizona."

ENTOMOLOGICAL PIONEERING IN ARIZONA

By A. W. MORRILL, *Phoenix, Ariz.*

In the selection of my title for this paper I do not wish to intimate that my field of action during the past three years has been one heretofore completely ignored by entomologists. It is a fact, nevertheless, that Arizona is entomologically in a pioneer stage of development. One by one the last few remaining states and territories have been yielding to the necessities for the organization and maintenance of an entomological service, and, not to be last, Arizona gave recognition to these necessities in 1909. Until that year Arizona was, in the words of Director R. H. Forbes of the State Experiment Station, "Entomologically lawless," and I may add entomologically needy of exploration and investigation. The state was, and is, a field for entomological work uniquely varied in itself, attractively different from other sections in its native insect fauna and above all affording excellent, if not unexcelled, opportunities for accomplishment in the exclusion of undesired pests as well as in insect investigations. Before dealing with the more recent entomological records and events, I will briefly review the "lawless" era prior to 1909 and as a further introduction I will outline our peculiar climatic and agricultural conditions upon which our entomological status, particularly from an economic standpoint, is dependent.

HISTORICAL. An examination of the indices of the Experiment Station Record, "Insect Life" and of other publications of the United States Department of Agriculture shows that in economic literature published prior to 1909, references to Arizona insects rarely occur. A

nearly complete history of economic entomology in Arizona up to the year mentioned is contained in the bulletins and reports of the State Agricultural Experiment Station. This Station was permanently organized in 1890 and two years later Prof. J. W. Toumey, now of the Yale Forestry School, was appointed botanist and entomologist in which capacity he served for about four years, when the title of entomologist was dropped. Professor Toumey's projects for investigation appear to have been confined to plant diseases. Two brief entomological bulletins were prepared by him, however, and published by the station.[1] Attention should be called here, in passing, to one of Professor Toumey's annual reports which will probably forever represent the irreducible minimum in departmental reports and serve as a standard which those of us subject to attacks of verbosity may well strive to emulate. Thirteen lines with a total of eighty-one words comprised the full text of this report.[2]

In October, 1899, Prof. T. D. A. Cockerell, at that time of the New Mexico Agricultural College, was engaged by the Arizona station to visit the Salt River Valley and to report upon the entomological conditions found there. As a result of this visit Bulletin 32 entitled "Some Insects of the Salt River Valley and Remedies for Them" was issued by the Experiment Station in December, 1899. This bulletin contains many interesting observations along economic lines and is one of our principal sources of information in regard to the status of insect pests in Arizona prior to 1909.

From 1900 to 1909 Professor Cockerell served as consulting Entomologist of the Arizona Station. During this time he contributed historic and descriptive matter and biological notes to Bulletin 56 dealing with the date palm scales (*Parlatoria blanchardi*) and (*Phoenicococcus marlatti*). During this period, also, various resident members of the Experiment Station staff,[3] included in their annual reports brief comments and notes on Arizona insects and entomological conditions. In regular bulletins, a chapter on "Extermination of Date Palm Scales" was contributed by Director R. H. Forbes to Bulletin 56, being based upon field work of which he assumed personal charge; and in Bulletin 58 Dr. J. E. Coit, then horticulturist on the Station Staff, devoted several pages to a discussion of citrus insects with original records of observations on the soft brown scale (*Lecanium hesperidum*), the citrus thrips (*Euthrips citri*) and the western leaf-footed plant bug (*Leptoglossus zonatus*).

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[1] Bul. 9, Insects and Insecticides, 10 pp. (1893), Bul. 14, Notes on Scale Insects in Arizona, 28 pp. (1895).

[2] Ninth Annual Roport, Agr. Exp. Sta., p.——, (1897).

[3] Director R. H. Forbes, Prof. J. J. Thornber, Prof. A. M. McClatchie, Prof. V. A. Clark, and Dr. J. E. Coit.

It is a matter of record which required no little searching of the statutes of the Territory of Arizona to disclose, that two laws relating to insects were enacted before the Horticultural Inspection Law of 1909. In 1891 a law was enacted providing for County Boards of Horticultural Commissioners to be appointed upon the initiative of orchard owners after the plan and with the authority and duties prescribed by the similar law at that time in effect in California. As far as known no county ever availed itself of the opportunity for horticultural protection afforded by this law and its existence has been generally forgotten.

The discovery of foul brood in a few colonies of bees in the Salt River Valley led to the enactment of an excellent law in 1899 entitled "An act providing for the suppression of foul brood among bees." Prompt action was taken in the extermination of diseased colonies and foul brood has never been known to exist in the state since that time, although in the Salt River Valley alone there are today between fourteen and fifteen thousand colonies of bees. For some unexplained reason the Foul Brood Law was not included in the 1901 Revision of the Territorial Statutes and at present we are as a consequence without any provision for apiary inspection or legal authority to act in case of the discovery of bee diseases.

The only insect legislation other than the foregoing, up to the year 1909, was embodied as a single clause[1] in an appropriation bill passed by the territorial legislature in 1907 providing the State Experiment Station authority to inspect and treat date palms for insect pests.

The first permanent organization of an entomological department in Arizona was provided for in 1909 by the passage of the Horticultural Inspection Law. The writer was appointed Entomologist for the Arizona Horticultural Commission and at the same time Entomologist for the Arizona Agricultural Experiment Station in September of that year. The progress of entomological work in the state since that time has been recorded in the four annual reports of the Arizona Horticultural Commission and in the twenty-first and twenty-second annual reports of the Arizona Agricultural Experiment Station.

General Climatic and Agricultural Conditions. The climate of the state of Arizona is characterized by a low rainfall, low humidity and a high percentage of sunshine. From Yuma with an altitude of 141 feet, a mean annual rainfall of 3.13 inches, an average humidity of 46 per cent, an annual mean temperature of 72.1° F., and recorded extreme temperatures of 22° and 118° F., Arizona includes under cultivation all gradations up to Flagstaff at an elevation of 6,907 feet

[1] The text of this clause is included in the First Annual Report of the Arizona Horticultural Commission, p. 2.

with a mean annual precipitation of 23.87 inches, an average humidity of 62 per cent, an annual mean temperature of 44.7° F., and recorded extremes of −21° and 93° F. The range in crop conditions is represented by the same points. On the Yuma mesa there is a body of land destined to become famous for citrus and other tropical and subtropical fruits, where injurious frosts are unknown, while at Flagstaff, owing to the short growing season, deciduous fruit trees seldom succeed in setting and maturing a crop, sweet corn from the home garden is a rarity, and the staple crops are limited to Irish potatoes and small grains. In its crop limitations and possibilities, therefore, the state of Arizona may be said to be fairly representative of the entire United States, California being the only other state to be similarly situated.

The same conditions which influence crops exert a corresponding influence upon insect pests, more especially the native species. The species introduced from other sections are in addition influenced in their distribution by the isolated condition of our principal agricultural districts, the Lower Colorado or Yuma Valley, the Salt River Valley, the Gila Valley, the Verde Valley and the Little Colorado Valley. Each of these is isolated by hundreds of miles of desert, forests and ranges of mountains, while numerous smaller irrigation projects, sub-irrigated valleys and dry farm sections are scattered over the state. In general the favorable circumstances noted has not only greatly delayed and restricted the distribution of insect pests thus far introduced, but offers for the present and future the most favorable opportunities for the prevention of the introduction and spread of pests not yet occurring in the state.

Characteristic Insect Records. In outlining the entomological conditions of the state as personally observed and as brought to my attention through correspondence during the past three years, it is only proper to explain that owing to the large amount of time which has been required in the organization of an inspection service and in the administration of our inspection law under the hampering influence of inadequate funds, comparatively little time has been available for investigations and observations. With the more suitable provisions for assistance and equipment obtained by means of a recent amendment of the original law, known as the "Arizona Crop Pest Law of 1912," more rapid progress in these lines is assured. Considering the more important economic insects, grouped by orders regardless of the crops affected, the following notes and observations will characterize the entomological features and will show some of the entomological peculiarities of the state of Arizona.

Orthoptera. In common with most of the other Western states we have grasshopper problems; alfalfa, young citrus trees and beans

being the principal crops to suffer from these insects. What is perhaps the most interesting species occurs in southeastern Arizona where it is a serious pest of the bean and alfalfa crops. It is one of the "lubber" species (*Tænipoda picticornis*), locally known as the "Military grasshopper." It breeds in the desert and feeds upon mesquite until nearly full grown when it overruns cultivated fields, if any are near to the breeding grounds. A peculiarity of the species habits, affording a convenient means of control, is that the insects climb trees, fence posts and other objects at night, evidently for protection. This habit at once suggests a ready means for trapping the insects or for early morning collections by hand. As bearing upon this grasshoppers need for protection against natural enemies, suggested by the habit mentioned, it should be noted that this strikingly marked species is apparently unpalatable to turkeys.

Thysanoptera. The citrus thrips (*Euthrips citri*) is the only notable citrus pest known to occur at the present time in the state. Citrus nursery stock does not appear at all subject to injury by this insect in Arizona as it is in the San Joaquin Valley of California. During the past four seasons only about one fifth of the citrus groves have had fruit sufficiently scarred to warrant remedial measures, but this small proportion has suffered extensively. The average damage varies less from year to year than does the damage in individual groves. Without any remedial measures or changes in cultural methods, the grove most severely damaged in 1911 produced fruit in 1912 which was practically free from the characteristic surface scarring.

The flower or grain thrips (*Euthrips tritici*) appears to be more destructive to deciduous fruits in the Salt River Valley than in other sections of the country. An instance of injury unusual in its severity has been recorded and illustrated in my second report.[1] More or less local damage is occasioned by this pest each year. It seems probable that the abundance of the flower thrips in the Salt River Valley is due to the long breeding season and to the large acreage of alfalfa, in the blooms of which the insect thrives.

Hemiptera. In many parts of Arizona the blood sucking cone nose (*Conorhinus sanguisugus*) takes the place of the bed bug as a household pest. In the Salt River Valley it is supposed that the bed bug does not exist. This insect has, however, been forced upon my observation in the Verde Valley at an elevation of about 2,000 feet. The unquestionable thriftiness of the insect at the point where this observation was made confuses any attempt to explain the apparently complete absence of the pest in the older and far more densely populated Salt River Valley at elevations a little more than 1,000 feet. Is it

[1] Third Annual Report Arizona Horticultural Commission, pp. 21–23.

possible that this ubiquitous insect has after all so delicate a constitution that it is unable to exist in a place which has somewhat of a reputation as a human health resort?

The squash capsid (*Pycnoderes quadrimaculatus* Guen.) is an insect which as a pest appears peculiar to the Salt River Valley of Arizona. Late squashes, cassaba melons and beans are subject to serious damage by this pest which promises to be a difficult one to control. The common squash bug (*Anasa tristis*), as might be expected from its history in other sections of the country appears to thrive in this state at all elevations, where squashes are grown. It has been recorded at elevations of 1,100 and 5,300 feet near Phoenix and Prescott, respectively.

The western leaf-footed plant bug (*Leptoglossus zonatus*) prevents the development of pomegranate growing upon a commercial basis in the Salt River Valley. The improved varieties of this excellent fruit can find good markets when uninjured fruit can be obtained for shipment. The same plant bug sometimes attacks oranges in destructive numbers and in the Blue River Canyon of eastern Arizona, has been observed attacking ripening peaches. The growth of Egyptian cotton in the Yuma and Salt River Valleys promises to become one of the most profitable industries of the state, and it remains to be determined whether this pest will attack the green bolls of this variety as I have observed it to do in the case of upland cotton in the Laguna district of Mexico.[1]

Various species of aphids, particularly the melon louse (*Aphis gossypii*), the cabbage louse (*Aphis brassicæ*) and the woolly apple aphis (*Schizoneura lanigera*) are common and troublesome in Arizona.

The grape phylloxera (*P. vastatrix*) was discovered infesting the leaves of a species of a wild grape near Prescott, Arizona, in 1911. In August, 1912, in the same locality, three cultivated vines in a vineyard two or three acres in extent, were found to be infested. The indications are that the insect is a native of the section of the state where discovered. Professor Quaintance of the U. S. Department of Agriculture, who referred specimens to Mr. Pergande for determination, informs me that this is his first record of the occurrence of the grape phylloxera in Arizona. So far as observed the insects were confined to the leaves. Mr. R. L. Nougaret of the U. S. Department of Agriculture engaged in investigating the grape phylloxera in California under the direction of Mr. Quaintance writes that he has never observed the leaf infesting form in that state. In the upper Gila Valley, Arizona, at elevation from 2,500 to 3,000 feet and in the Salt River

[1] Bul. 54, Bureau of Entomology, U. S. Department of Agriculture.

Valley, at elevation 1,100 to 1,300 feet the grape phylloxera is as yet unknown.

Among leaf hoppers the best known economic species are the sugar beet leaf hopper (*Eutettix tenella*) occurring in the Salt River Valley where it is apparently a native, and two grape leaf hoppers (*Typhlocyba comes*), in the Gila Valley, and *Dicraneura cockerelli* in the Salt River Valley. In view of the scarcity of representatives of the family Aleyrodidæ in arid regions, it is of interest to note that the larvæ and pupæ of one apparently undescribed species of the genus Aleyrodes, frequently nearly completely cover the under surfaces of the leaves of its chief food plant, known as wild tobacco.

The scale insects of Arizona are very interesting but can only be touched upon in this paper. The San José scale was first recorded as present in the Salt River Valley nearly twenty-five years ago. So far as known this species is of no economic importance at present, since I have never found it in orchards in the state, nor has a single instance of injury by it been reported to my office. During the present year it is planned to secure more definite information concerning the status of this scale, and to determine if possible whether climatic conditions or parasites are responsible for its apparent inability to maintain itself injuriously in the state. The soft brown scale (*Lecanium hesperidum*) is notable in its occurrence in the Salt River Valley. Here it seems dependent upon the oleander, a very common ornamental, and rarely attacks the citrus, fig, china trees, pepper tree, rose or other food plants except when such are located near to an infested specimen of the preferred oleander. After the oleander is destroyed the colony gradually weakens and disappears. On this food plant the insect shows no preference for the shaded parts and in fact the young appear to settle by choice upon the upper surfaces of the leaves on the portions of the trees most exposed to the sun. In Florida the soft scale thrives on young citrus trees to the full extent permitted by its natural enemies, regardless of the existence of oleanders. During three years spent in Florida in white fly investigations numerous instances of temporary injury to young citrus trees by the soft scale were noted at Orlando and other points in that state, but this insect was never so abundant upon oleanders as to attract my attention. At my request, Mr. W. W. Yothers of the Bureau of Entomology, stationed at Orlando, has recently made a special examination of many oleanders in that city with the result that my impression concerning this matter is verified. Prof. H. J. Quayle recently writes that in California he has never observed any preference of the soft brown scale for the oleander over other food plants. The California red scale (*Chrysomphalus aurantii*) was discovered for the first time in

a citrus district in Arizona at Phoenix in June, 1912. Fortunately it was confined to one rose bush with the exception of a few specimens found on another rose a short distance away. A citrus tree fifty feet away and other roses of which there were a great many were apparently free from the insects. Prompt action was taken and it is believed that the colony was exterminated. The infested rose bush was brought to Phoenix from Pasadena, Cal., four years ago, before the inspection of imported plants was provided for. In 1912 when discovered the insects completely covered the larger branches of the bush. I am informed by Professor Quayle that in his observation citrus is the preferred food plant in California for the red scale. The condition as noted in Arizona is not an indication, as it might appear, that here the rose is the preferred food plant, since the insects had only recently spread to one of the nearby roses while many others scarcely farther away had been neglected as absolutely as had the citrus tree, so far as careful inspections could determine. Other scales which should be mentioned are the Parlatoria scale (*P. blanchardi*) and the Marlatt scale (*Phæniococcus marlattii*) both of which attack the date palm. These scale insects, imported from Africa, have called into use the blast torch, an instrument which was privately exploited as an insect destroyer some years ago. The usefulness of this means for destroying the date palm scales, however, was demonstrated by Director Forbes of the Arizona Station in experiments conducted in 1905, 1906 and 1907.[1]

Lepidoptera. The corn ear worm (*Heliothis armigera*), codling moth (*Carpocapsa pomonella*), alfalfa butterfly (*Eurymus eurytheme*) and variegated cut worm (*Peridroma margaritosa saucia*) are about in the order named the leading pests of crops in Arizona among the lepidopterous insects. The marked preference of the larva of the variegated cut worm for alfalfa over other food plants, as exhibited in the Salt River Valley in 1911, was believed to be unusual. During the past season a similar striking preference was exhibited by the the same insect near Prescott and in the Little Colorado Valley, both instances being at elevations a little over 5,000 feet. In the case of the outbreak near Prescott, however, after the alfalfa was cut the capability of the worms for destroying garden crops was thoroughly demonstrated.

In Arizona the eastern grape leaf skeletonizer (*Harrisina americana*) is represented by related species (*H. coracina* and *H. metallica*). One species in the caterpillar stage differs from the eastern species by having cross bands consisting of blue dots but appears to have feeding habits which are identical with its eastern relative.

[1] Bul. 56, Arizona Exp. Sta. pp. 199–203, (1907).

The discovery of the Eastern peach tree borer (*Sanninoidea exitiosa*) in two sections of Arizona has been noted in two publications of the Arizona Horticultural Commisssion.[1] Where observed the injury was severe owing to the failure of the owners of the infested trees to recognize the presence of the insects. It is strangely fortunate that the insect has never been found or borer injury reported from any of the important fruit growing sections of the state. I was informed by Dr. C. P. Gillette several months ago that a similar situation existed in Colorado.

Coleoptera. As a substitute for the Eastern rose chafer (*Macrodactylus subspinosus*) Arizona has a western form of the same genus (*M. uniformis*) with similar habits.[2] Instead of the fig eater (*Allorhina nitida*) which is so common in the southeastern United States, Arizona has a substitute in the misnamed "green June beetle" (*Allorhina mutabilis*) which has a far more destructive appetite. Peaches and figs are badly and generally injured by these beetles wherever grown in the state. Apples were observed to be seriously attacked in one instance in eastern Arizona at Thatcher, but this visitation is believed to have been principally due to the scarcity of fruit in the peach orchards. The ripening fruit of the date palm is attractive to several insects and among these a small nitidulid beetle (*Carpophilus dimidiatus*) heretofore considered harmless, has been found to be a serious enemy, breeding in this fruit in enormous numbers. Possibly this is the first record of a member of this family being of economic interest. Notwithstanding the impression frequently expressed to the effect that the Colorado potato beetle (*Doryphora decimlineata*) exists in the United States wherever Irish potatoes are grown, this pest is of only limited distribution in Arizona. It is well established and moderately injurious near Prescott at elevations slightly over 5,300 feet and infests only a small percentage of the farms near Williams and Flagstaff, at elevations near to 7,000 feet, where the principal potato growing section of the state is located. Of more importance than the Colorado potato beetle as enemies of potatoes in Arizona are three blister beetles which owing to a mishap have not been determined specifically.

The bean lady bug (*Epilachna corrupta*) is one of the most destructive beetles in Arizona. This has been observed or authoritatively reported from Thatcher, Clifton, McNeil, Prescott and Taylor, representing elevations from 2500 to 5500 feet. It is unknown in the Salt River Valley.

Diptera. The typhoid or house fly is as undescribably numerous

[1] Circular 16, p. 23, 1911 and Fourth Annual Report, p. 31 (1912).
[2] Third Annual Report Arizona Horticultural Commission, pp. 23–24.

and offensive in Arizona as it is in the average state. In the section of the state where typhoid fever is most prevalent, there is rather strong evidence that this insect and not the water supply is largely responsible for the spread of the disease. The same insect is no doubt an important agent in the spread of trachoma, an eye disease which is particularly prevalent among the Indians.

The alfalfa gall midge (*Asphondylia miki*) originally described from Europe and reported by Professor Webster[1] during the past year as occurring in Salt River Valley and vicinity has thus far proven of but little economic importance in Arizona. Characteristic galled seed pods were discovered in the northeastern part of the state at St. Johns in September, 1911, and in September, 1912, at Holbrook. Both of these occurrences are so isolated as to almost preclude the possibility of artificial introduction. At Holbrook there is no farming done and the infested pods were on a few volunteer alfalfa plants. It seems safe to predict that a wild food plant will eventually be found in Arizona.

Hymenoptera. In this order Arizona has three pests of high rank in the clover seed chalcis (*Bruchophagus funebris*), the harvester ant (*Pogonomyrmex barbata* vars) and leaf cutter bees, of possibly more than one species. The clover seed chalcis not only causes a direct loss to alfalfa seed growers in Arizona of more than $100,000 per year, but dissipates the hopes for the development of the seed producing industry which the state is peculiarly suited for climatically, until some satisfactory method of avoiding the injury is worked out. The past year was marked by a still further decline in alfalfa seed production in the Buckeye Valley, which as a new district became noted for its alfalfa seed several years ago.

The harvester ants are responsible for the large and numerous bare spots which are found in the alfalfa grain fields, particularly in the Salt River Valley In this connection a use for London Purple not generally known to entomologists should be noted. This poison owing to its fine state of pulverization seems especially adapted for placing around the entrance of the nests of the ants where it may adhere to the feet of the insects and be carried into the nests to poison the food supply. I have been unable to obtain any early history of the use of London Purple in this manner. Sometimes ineffective lots may be obtained. Two years ago analyses were made of a series of samples which represented, as shown by thorough field tests, various degrees of effectiveness.[2] It was my expectation that the analyses would provide a chemical basis for selecting grades of London Purple

[1] Circular 147, Bureau of Entomology, U. S. Department of Agriculture, (1912).
[2] Twenty-first Annual Report Arizona Horticultural Experiment Station, p. 391.

which were suitable for use against ants. The results were disappointing and perplexing, no relation being shown between the amount of arsenic present and the results secured by field tests. Whether a mechanical basis can be discovered for the object mentioned remains to be determined.

Leaf cutting bees are the cause of much damage to young fruit trees in southern and eastern Arizona. In the Salt River Valley roses appear to be the only plant subject to injury. Specimens of the species concerned have not been captured by myself or by my correspondents with the exception of a single specimen which reached me in a broken condition.

ENTOMOLOGY AND THE ARIZONA PUBLIC. The foregoing records which purport to be merely a general characterization of the economic insect fauna of Arizona indicate the extent of the field now open for work in that state. While we are still fortunately free, as far as known, from many of the most destructive insect pests of the country, there is no scarcity of native insects with predilections for cultivated crops.

The need for entomological protection and entomological investigations is being more and more generally recognized in the state. In 1909 the first appropriation of $3,000 per annum for entomological work was made in the territorial assembly after a hard fight for recognition by the interests most concerned. In 1912, with urgent necessity for economy in all appropriations, the state legislature by a unanimous vote in both houses passed a bill amending the original law and adding $9,000 a year to the original amount. The outlook for future accomplishment in economic entomology in Arizona is most promising and the continued favorable attitude of the public is hopefully anticipated.

PRESIDENT W. D. HUNTER: Two of the most striking entomological observations made on a recent trip in the arid southwest dealt with the house fly and mosquitoes. One would not naturally expect to find an abundance of these insects in such a region. Artificial circumstances tend to overcome natural obstacles in the breeding of these insects. The water used for irrigation allows the mosquitoes to breed in great numbers and carelessness about the disposal of garbage allows great numbers of house flies to be bred.

We will now listen to a paper by Mr. S. J. Hunter on "Apparatus for Maintenance of Thermal Climatic Conditions."

APPARATUS FOR MAINTENANCE OF THERMAL CLIMATIC CONDITIONS

By S. J. HUNTER, *Lawrence, Kans.*

[A summary of this paper appears in the discussion below.—*Ed.*]

PRESIDENT W. D. HUNTER: Any discussion?

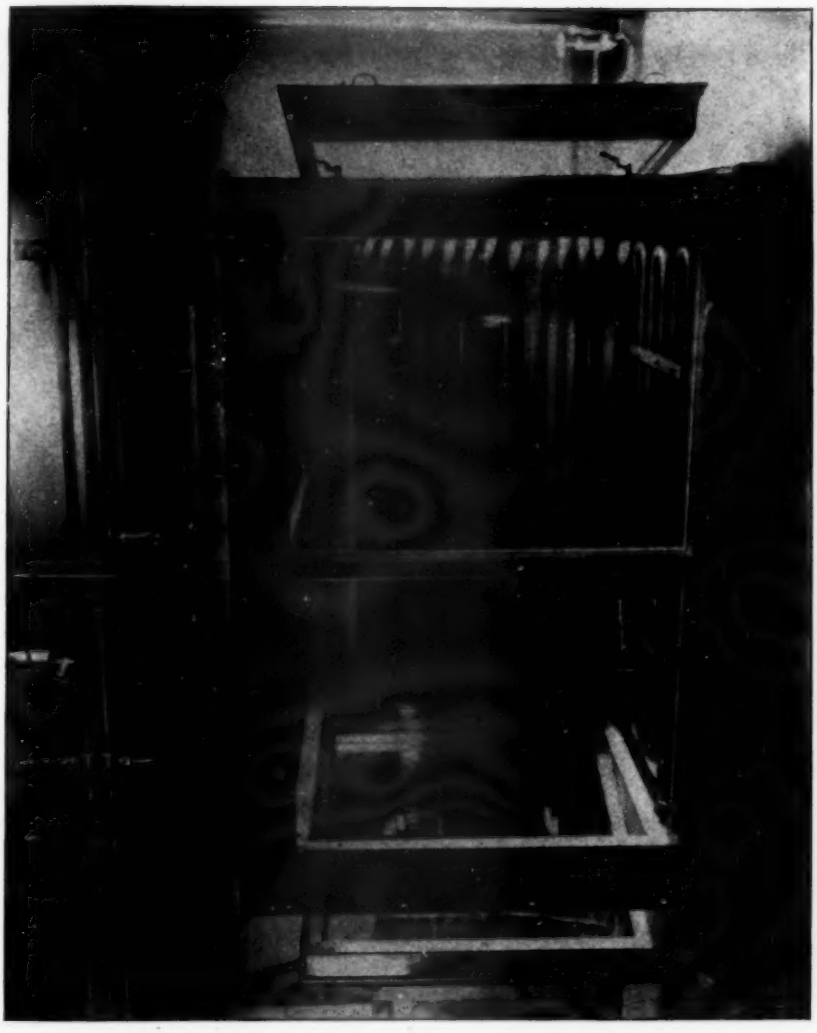
MR. T. J. HEADLEE: I am very much interested in this subject and should be glad to have the speaker explain the following points: 1st, whether the temperature maintained is supposed to be a constant one, or whether it is intended to show a diurnal variation; 2d, the exact source, nature, measurement or control of the light; 3d, the control of atmospheric moisture.

MR. S. J. HUNTER: This temperature control apparatus (plates 5, 6) is constructed to fulfil our specific requirements. I do not undertake to say that it will fulfil hypothetical conditions arbitrarily imposed. The chamber is 5′x 5′x 8′, double glass lined on four sides. The temperature is controlled by an ammonia compressor, while the power is furnished by a ¾-H.P. D.C. motor. Sunlight can be admitted from the south and west or excluded as desired, leaving daylight from the north. We can maintain constants or variables from 60° above to 10° below zero F. Standard constant conditions are easier to maintain than the establishment of given curves of variation. Constants do not occur in nature; hence, for the present with these we are not concerned. Standard weather guages keep the records. The purpose of this apparatus is to interpret the influence of temperature and moisture as natural climatic conditions on growth and development. The climatic data is taken from our climatic records, continuously observed since 1868.

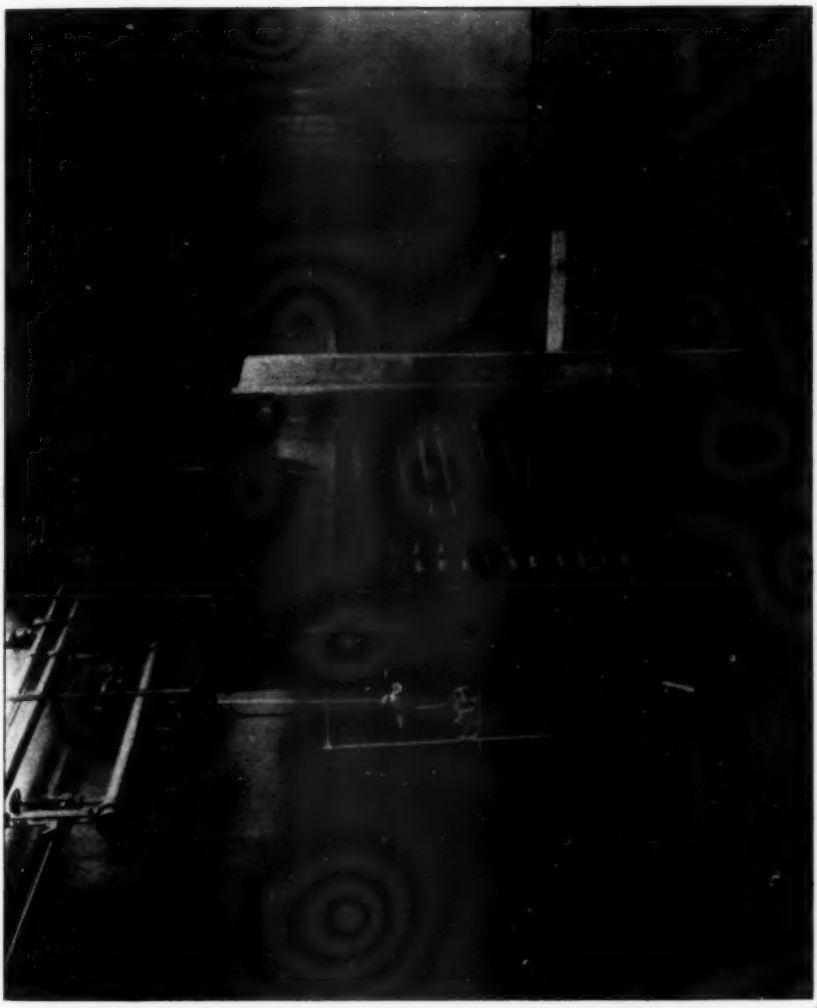
MR. T. J. HEADLEE: How does the speaker plan to control or determine the relative proportion of gases in the air?

MR. S. J. HUNTER: Ventilation can readily be secured and normal conditions of surrounding atmosphere maintained through ventilators aided by electric fans. The moisture content can be controlled by chloride of lime filtration.

MR. T. J. HEADLEE: In the study of the effects of temperature and moisture on the rate of insect metabolism I have not found it possible to control the intensity of the light. The difference in the results obtained from experiments conducted under the same temperature and moisture and under practically the same food and gas conditions at different times of the year are difficult to account for so long as the intensity of the light is an unknown factor. In fact, it is possible that the ascribing of a difference in response obtained



APPARATUS FOR MAINTENANCE OF THERMAL CLIMATIC CONDITIONS. MAINTAINS NORMAL DOWN TO 10° BELOW ZERO *F*. UNIVERSITY OF KANSAS, Lawrence, Kansas.



APPARATUS FOR MAINTENANCE OF THERMAL CLIMATIC CONDITIONS. MAINTAINS NORMAL DOWN TO 10° BELOW ZERO *F.* UNIVERSITY OF KANSAS, Lawrence, Kansas.

from organisms under different temperature conditions; but under similar moisture, food and gas conditions conducted at different times of the year to the measured difference in temperature is hardly justifiable. I regard the control of the sunlight variable as the most difficult of all the climatic variables in this sort of study.

MR. E. P. FELT: I want to call attention to an apparatus which might be useful to entomologists along this line, and that is a very efficient device for maintaining low temperature. It is simply a series of furnace pipes passing through the ordinary type of cold chamber and packed with ice and salt. One or more pipes may be used and by varying the relative amount of salt and ice considerable modification in the temperature may be obtained.

MR. E. C. COTTON: Regarding the question of sunlight I think that for most experiments it is not an important factor. If it is, one can darken the room and use artificial light. With an arc light using carbons impregnated with certain chemicals we can closely simulate daylight. In regard to Dr. Felt's suggestion I think that we are making a mistake by attempting to cool the air by means of pipes within the room itself. It is impossible to hold the temperature constant with cooling pipes of any kind in the room because of residual cooling from the cold mass of metal after the absorbing agent (brine or expanding gas) has been shut off. I believe that it is necessary to cool or heat the air outside of the room using a thermo-regulator to determine when and what kind shall be introduced. I find in our work that an electric regulator is out of the question, the regulator we are using depends upon the expansion of gases.

PRESIDENT HUNTER: The next paper will be presented by Dr. Britton.

RECENT STUDIES ON THE WEEVIL AND THE BUD MOTH OF THE WALNUT AND A SAWFLY ATTACKING BLACKBERRY

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

Attempts to grow the English or Persian Walnut, *Juglans regia*, as well as certain other species of *Juglans* in Connecticut have almost failed, largely because of two insects which attack the trees, the walnut weevil or curculio, *Conotrachelus juglandis* Lec., and a bud moth belonging to the genus *Acrobasis* and probably referable to the species *caryæ* Grote.

Studies of the life histories and habits and of the injuries caused by these two pests, were made during the past summer on the farm of Dr. Robert T. Morris at Stamford and the walnut weevil was also

studied on the grounds of Mr. H. L. Champlain at Lyme. Most of the field work was done by my assistant Mr. H. B. Kirk.

In nearly all of the references to the walnut weevil in a somewhat scanty literature, this insect is said to breed in the nuts, but in Connecticut the larvæ do great damage by tunneling in the new shoots. In most cases infested trees produce little fruit as the shoots soon wither and die.

There is but one generation each year and the overwintering adults appear the latter part of May and feed upon the stems and leaf-veins. About the last week in May the females begin to lay eggs in the stems in irregular crescent-chaped punctures under flaps, like those of the plum curculio. The egg-laying period continues until the first of August, and after the nuts have formed some eggs are laid in them. The eggs require from six to twelve days for hatching, depending probably upon the weather. The larvæ tunnel in the stems of the shoots usually working upward, though going in both directions, and the frass is thrown out laterally through the egg punctures. From four to six weeks are necessary for larval development which ceases in the stems about September 1, and larvæ hatching from eggs laid after about July 20 do not mature. In the fruit the larvæ feed in the kernels but return to the shucks to finish their development. When mature, they go an inch into the ground and pupate about ten days later. The adult beetles emerge from sixteen to twenty days after pupating, fly to the trees and eat holes at the base of the leaf petioles.

In Connecticut the species of walnuts (*Juglans*) are attacked and injured in the following order, those first named being the most damaged: *cordiformis, sieboldiana, cinerea, regia, mandshurica, nigra.*

Our limited tests indicate that this insect may be controlled by spraying with lead arsenate in the usual proportions. Probably two applications should be given,—the first about May 20 in Connecticut, and directed against the under side of the leaves; and the second three or four weeks later.

The walnut weevil occurs in Quebec and Ontario, Canada, and southward to the Gulf of Mexico, and at least as far west as Texas, Kansas, Nebraska, Iowa and Wisconsin.

The bud moth evidently prefers *Juglans regia*, but also attacks and injures *cinerea* and *nigra*. There are three generations each season. The eggs are laid singly at the base of the bud about the second week in May for the first brood, July 1 for the second brood and August 15 for the third brood. They hatch in from six to ten days. Nearly four weeks are required for the larvæ to become mature, when they pupate in the stems and adults emerge from two to three weeks later. Sometimes the larva feeds upon the exterior and perhaps wholly on

one side of the stem, but usually it tunnels downward from the terminal or from an axillary bud being concealed all the while.

The frass is retained at the entrance of the burrow and being fastened to leaves, helps to form the nest where pupation occurs, and which is the most conspicuous evidence of the presence of the bud moth. The frass is never exuded laterally from the burrow as is the case with the walnut weevil.

The bud moth does about as much damage to the Persian walnut as does the weevil, and like that species can be controlled by spraying with lead arsenate. In fact, the same treatment is effective against both insects. Probably the winter is passed in the larval stage, though this point is not settled.

The bud moth may prove to be *Acrobasis caryæ* Grote or a new species.

Early in the summer of 1910 my assistant, Mr. B. H. Walden, collected in a blackberry plantation near New Haven some adult sawflies which Dr. A. D. MacGillivray pronounced a new species. In 1911, he noticed that some of the plants in the same field had been defoliated by saw-fly larvæ, but no adults were reared that season. In 1912, additional material was gathered and the adults reared from the larvæ proved to be identical with those collected in the same field two years before and were described by Dr. MacGillivray in the *Canadian Entomologist* Vol. XLIV, October, 1912, page 297, as *Pamphilius dentatus*.

The eggs are laid in rows on the leaf-veins the first part of June. The eggs soon hatch and from fourteen to seventeen days are necessary for the larvæ to reach maturity, when they go into the ground and remain until the following spring before pupating. The adults appear the latter half of May. The larvæ spin threads by means of which they draw a portion of the leaf over themselves forming a protecting tube in which they feed. One tube may serve as a nest for several larvæ or it may contain a single occupant. The habits are quite similar to those of the peach saw-fly, *Pamphilius persicum* MacG. studied by Mr. Walden in 1907.

Detailed accounts of these studies together with such other facts as are known about the walnut weevil, walnut bud moth and the blackberry saw-fly, may be found in the twelfth Report of the State Entomologist of Connecticut, which is Part III of the Annual Report of the Agricultural Experiment Station for 1912.

At the conclusion of this paper the business session was resumed, after which the meeting adjourned.

The following papers were read by title and in accordance with the practice of earlier years are included in the printed proceedings.

ADDITIONAL NOTES ON THE BIOLOGY OF THE ROCKY MOUNTAIN SPOTTED-FEVER TICK[1]

By F. C. Bishopp and W. V. King

The Rocky Mountain spotted fever problem is becoming familiar to most entomologists, although until the last few years it was generally considered a medical problem. The splendid work of the late Dr. H. T. Ricketts during 1906 and the three succeeding years, which clearly showed that the tick, *Dermacentor venustus*, is the carrier of the disease, greatly stimulated the interest of entomologists in this field. As was first indicated by Dr. Ricketts[2] and later clearly outlined as a result of investigations conducted by the Bureau of Entomology[3] in coöperation with the Montana Experiment Station,[4] the combatting of the disease resolves itself into a fight against the transmitting agent.

The problem should not be considered a local one. In the Bitter Root Valley in Montana, where the disease occurs in its most virulent form, from 70 to 80 per cent of the ten to twenty cases which occur there annually result fatally. In Idaho alone, at least 375 cases occur each year, according to Dr. E. E. Maxey. The death rate in Idaho is much lower but the slow recovery of many of the patients adds materially to the economic loss. Hunter and Bishopp have estimated the total number of cases which occur annually in the United States at 750 with seventy-five deaths. The disease is not prevalent throughout all of the tick-infested territory but is known to occur in Alaska, Washington, Oregon, California, Nevada, Utah, Wyoming and Colorado in addition to Montana and Idaho, and it probably occurs also in British Columbia.

The authors desire to acknowledge the helpful suggestions of Mr. W. D. Hunter and Prof. R. A. Cooley under the general direction of whom this work has been done. Professor Cooley is responsible for the observations made on longevity in the Bitter Root Valley during the spring of 1912. The assistance of Mr. H. P. Wood in conducting experiments and making observations at Dallas, Texas, is also gratefully acknowledged.

Seasonal Activity of Adults

Since the adult tick is with rare exceptions the only stage which attacks man and since the most feasible control measures consist of

[1] Published by permission of the Chief of the Bureau of Entomology.

[2] Spotted fever report Nos. 1 and 2—4th Bien. Rept. St. Bd. Health, Montana, pp. 87–191, 1909.

[3] W. D. Hunter and F. C. Bishopp—The Rocky Mountain Spotted Fever Tick—Bull. 105, Bur. of Ent., U. S. Dept. Agr., 1911.

[4] R. A. Cooley—Tick control in relation to the Rocky Mountain spotted fever—Bull. 85, Mont. Exp. Sta., 1911.

the destruction of the adult ticks on the domestic animals, the determination of the period of activity of this stage is of importance. The first appearance of the adults occurs shortly after the first warm days of early spring. The date of appearance varies somewhat according to the latitude, altitude, and, in a given locality, the climatic conditions, particularly the temperature, have their influence. One of the present authors (King) determined rather accurately the date of first appearance of adults in the Bitter Root Valley in 1910 and 1911. March 11 and March 15, respectively, were the dates when the first ticks were found during these years. The mean temperature at Missoula, Mont., which is located near the mouth of the Bitter Root Valley, was 43°F. or 8.2°F. above normal during March, 1910, and 39°F. or 4.1°F. above normal during March, 1911. The minimum temperature during March, 1910, was 21°F., while a minimum of 0°F. was reached in March, 1911. At Hamilton, Mont., which is in the center of the valley, the mean temperature for March, 1910, was 46.8°F. and for March, 1911, was 41.9°F. The much warmer March experienced in 1910 than in 1911 no doubt explains the slightly earlier appearance of ticks in 1910 than in 1911. We may also conclude that the appearance of adults at a date earlier than March 11 must be extremely rare as the winter of 1909–10 was not more severe than usual and the March temperatures were much warmer than normal.

At Rifle, Colorado, in 1910, ticks appeared shortly before March 23, while in 1911 they appeared between March 3 and March 14. The temperature was considerably higher during the latter part of February and during early March of the latter year. During 1911 the first appearance of adults was recorded in a number of different sections as follows: Round Mountain, Nevada, about March 8; Viewpoint, Oregon, March 10; Weatherby, Oregon, March 14; Vernon, Idaho, March 27; Buford, Wyo., about April 1.

It appears that the zero of effective temperature of this species is not far from 35°F. It is certain that this point is considerably lower than in the case of insects and ticks which occur in southern latitudes. The accumulated effective temperature (computed in daily units of mean temperature) necessary to produce emergence from hibernation is low, apparently being in the neighborhood of 37° F. Adults may be expected to begin emerging within six to twelve days when the daily mean ranges between 38°F. and 42°F. for several consecutive days. The data at hand indicate that there is no active period between the semi-active summer or æstivation period and hibernation. The temperature at which dormancy is produced in the fall seems to be about 10°F. to 15°F. higher than that producing emergence from hiber-

nation in the spring. The question of the relation of climate to this tick will be treated more fully in a subsequent paper.

The date of the disappearance of adults is much more variable than is the time of beginning emergence from hibernation. The greatest abundance of adults occurs during April and May. During June the number rapidly diminishes so that by the first of July very few specimens are to be seen attached to hosts. During the warm summer days, especially toward the latter part of summer, the adults begin leaving the plants upon which they rest while awaiting hosts, and crawl down beneath the grass and leaves. These ticks may be aroused and will occasionally attach, although after August 1 they seem extremely reluctant about feeding and endeavor to escape from the host when applied. In about thirty tests of attachment made after August 15, in but three cases were specimens induced to attach to hosts, and none of these engorged or copulated.

At high altitudes the activity of adults is continued to a later date in summer than at lower ones. For instance, at Virginia Dale, Colorado (altitude 7,200 ft.) on June 24–25, 1910, a considerable number of ticks, some of which were well engorged, were taken on horses and cattle, while at altitudes of 5,300 feet no specimens were to be found on hosts. A similar condition was observed in the Bitter Root Valley on July 9, 1911, when numerous unengorged adults were found on our clothing above Lake Como at an altitude of from 5,500 to 6,500 feet, while in the Valley proper at an altitude of 3,000 to 4,000 feet very few specimens were seen.

The last adults observed during the investigations of 1910 in the Bitter Root Valley were seen on hosts July 16. In 1911 straggling adults were active to a much later date, the last being observed on August 21. This difference may be accounted for by the much warmer weather which occurred from March to July, 1910. The mean temperature during each month of this period was from 2°F. to 8.2°F. above normal, making a total accumulated temperature above the normal of 24.2°F., while in 1911 the mean temperature from March to July was exactly normal, July being below normal.

In 1911 the last adults were seen on the following dates at the different points: Florence, Mont., August 21; Darby, Mont., July 9 (no subsequent examinations); Viewpoint, Oregon, September 25; White Pine, Mont., September 31 (no subsequent examination). In 1912 the last adults were seen at Virginia Dale, Colo., August 31 and at Viewpoint, Oregon, September 9. The late occurrence of adults at Viewpoint, Oregon, may be due to the comparatively low mean temperature during the summer months, as well as the absence of very high maxima.

As has been indicated in the foregoing statements, and previously discussed in other articles,[1,2] the greatest activity of adults occurs in the spring and early summer. This is especially true in regard to their feeding. This spring feeding habit is not only shown by adults which mature in the early part of the season, but also by those individuals which hibernate as adults having molted from nymphs the previous season. While the former class of individuals does not show any desire to feed during the summer or fall, those individuals which have hibernated show a tendency to remain active later in the summer. This habit has been observed in large cage experiments in the Bitter Root Valley as well as in cages at Dallas, Texas. It was formerly supposed by many that the factor which limited the season of adult activity to the spring and early summer months was that the overwintering adults either obtained hosts or died before about July 1. This is not true, as we have found hibernated adults to pass to the ground in July and remain inactive till the following spring when they again appeared for feeding. During the past summer, at Viewpoint, Oregon, Mr. H. H. Hatch, who kept careful watch on the activity of ticks, observed them to become very scarce the last of June and remain so throughout the summer. In September, however, a slightly greater number of adults was found. Throughout this period no individuals more than one-half engorged were observed on hosts.

Distribution and Hosts

Little additional information has been secured on the general distribution of this species since the publication of articles on this subject by Bishopp[3] and by Hunter and Bishopp.[4] Our knowledge of the extent of infested territory in California has been increased by the receipt of specimens from Madeline, Lassen County.

The host relations of this tick have been discussed in a number of publications. As has been pointed out by Hunter and Bishopp,[5] the mountain goat serves as a host for a considerable number of the adults of this species. Immature stages may also develop on this animal. However, it has been found that a number of small mammals occur on the mountains inhabited by the goats and act as host for the immature stages. The question of the mountain goat acting as a

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[1]Hooker, W. A., Bishopp, F. C. and Wood, H. P.—The life history and bionomics of some North American ticks—Bull. 106, Bur. of Ent., U. S. Dept. Agr., 1912, p. 178.

[2]Bull. 105, Bur. of Ent., U. S. Dept. Agr., 1911, p. 26.

[3]Bishopp, F. C.—The distribution of the Rocky Mountain spotted-fever tick—Cir. 136, Bur. of Ent., U. S. Dept. Agr., 1911, p. 4.

[4]Bull. 105, Bur. of Ent., U. S. Dept. Agr., 1911, pp. 15–17.

[5]Bull. 105, Bur. of Ent., U. S. Dept. Agr., 1911, pp. 28-29.

reservoir for Rocky Mountain spotted fever has been much discussed by most of the investigators who have been carrying on work in the Bitter Root Valley. The recent discovery, reported by Rucker,[1] of an infected tick on the mountain goat is of much interest. As is commonly known, the disease occurs mainly on the western side of the Bitter Root Valley. On this side the mountains ascend abruptly from the floor of the valley and thus furnish a suitable habitat for the mountain goat. The goats do not come into the Valley proper but during the winter frequent the more precipitous portions of the mountains immediately adjoining the Valley at a number of points along the western side. With the possibility that the mountain goat is a natural reservoir for the disease virus, infected ticks in the immature stages may be carried by small wild animals from the higher altitudes to the lower regions where native cattle graze. The habit of the goats of retreating into higher elevations as the season advances would minimize this danger, however.

A very few angora goats are kept by residents on the west side of the Valley. Although we have found that this animal may act as a host for adults of the spotted-fever tick, there is not sufficient evidence at hand to warrant any statement regarding the possibility of this animal being susceptible to spotted fever.

Hibernation

Investigations in the Northwest during 1910 and 1911 indicated that hibernation takes place only in the nymphal and adult stages. During the winter of 1911, however, this idea was proven to be fallacious. Out of a total of about forty-five lots of seed ticks which hatched from eggs during the summer and fall of 1911, a considerable number in thirty-two lots was found to be alive and active in the spring of 1912, thus proving that it is possible for large numbers of the tick to hibernate in the larval stage.

A number of nymphs which were engorged by one of the authors (King) during the summer of 1910 did not transform to adults until the following summer, thus showing that it is also possible for the tick to pass the winter in the engorged nymphal stage. Under natural conditions it appears that the majority of the nymphs which drop from hosts before August 15 molt to adults and hibernate in that stage. The examination of a large number of hosts of the immature stages in several localities shows that very few nymphs are to be found on them after August 15, thus indicating that few ticks enter the winter in the engorged nymphal stage.

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[1] Rucker, W. C.—Rocky Mountain spotted fever. Public Health Reports, Vol. XXVII, No. 36, 1912, p. 14.

It has been supposed that different stages of ticks are probably carried into the winter quarters of ground squirrels and other animals. There seems little doubt that a few larvæ and nymphs are still attached when the animals enter hibernation. Other species of ticks have been found in considerable numbers in burrows of animals during the summer and in one instance Mr. C. Birdseye found a two-thirds engorged female of *Ixodes æqualis* Banks in an underground nest of *Citellus beecheyi* on February 25, 1911, at Modesta, Cal. With a view of determining if specimens of the spotted-fever tick are to be found in the winter nests of ground squirrels, one of the authors (King) had a number of squirrel burrows dug up during the first part of October 1910, about one and one-half months after the time of hibernation. No hibernating squirrels were found but forty nests (probably summer nests and containing live mites and fleas) were secured and immediately placed in tick proof sacks. The contents of twelve of these nests were thoroughly examined and the sacks containing all the nests were searched without finding any ticks. Two other nests which had undoubtedly contained hibernating squirrels a few days previous and which were found by following fresh badger diggings were also examined with the same negative result. For comparison with this several quarts of trash from around the entrance of one burrow was sacked on September 26. By searching only the top of the sack two adults and four nymphal ticks, which had crawled from the trash, were found.

Life History

Records made by one of the authors (King) in the Bitter Root Valley present some variations, from those published heretofore, in the longevity and the developmental periods of different stages of this tick. A few of the records are here given. The greatest longevity of larvæ previously recorded was 117 days. This record was made in 1910. Larvæ hatched in July and August, 1911, went through the winter, and in a number of lots were still alive when last observed on June 11, 1912. On May 16, 1912, some of these were taken from the outdoor tubes in which they were kept and sent to Dallas by Professor Cooley. These attached and engorged readily when applied to guinea pigs at Dallas, Texas, on May 22. The maximum longevity in these lots exceeded 317 days. It was observed that some larvæ had died before the advent of cold weather in the fall of 1911.

The first two and the last records given in the following table were made on ticks kept in glass cylinders with gauze tops and kept out of doors in partial shade. The third record was made on ticks kept in the same kind of container but in the open field. The other three lots were

kept in pill boxes in a building; the eggs being separated and placed in test tubes in partial shade out of doors on July 14.

TABLE I—PRE-OVIPOSITION, DEPOSITION, INCUBATION AND LARVAL LONGEVITY

Date ♀ dropped	Date deposition began	Pre-oviposition period	Deposition complete	Deposition period	Hatching began	Incubation period	All larvæ dead	Larval longevity
1911	1911	Days	1911	Days	1911	Days		Days
April 14	June 12	59	July 15	33	Aug. 17	66	Oct. 16, 1911–April 10, 1912	60–237
April 14	June 12	59	Aug. 7*	56*	Aug. 24	73	June 11, 1912, many alive	292+
April 29	May 30	31	.....	.....	July 1	31	Sept. 1, 1911	31
April 29	June 3*	40*	July 24	46*	July 26	48*	June 7, 1912, 200 alive	317+
May 11	June 8*	28	July 23	45*	Aug. 6	59*	April 10, 1912, many alive	248+
May 31	June 27	27	July 23	26	Aug. 10	44	April 10, 1912, many alive	244+
June 19	July 9*	20	.....	.....	Sept. 7	57	June 11, 1912, many alive	278+

* The first viable eggs were deposited July 12.

Recent records on the engorgement of larvæ show no marked deviation from those already published. The shortest engorgement period noted was forty-seven hours.

The shortest period from dropping to molting of larvæ observed in 1911 was fifteen days, while in 1910, owing to higher temperature, some molted in eleven days. The longest molting period was thirty-one days. This record was made on larvæ which dropped from a ground squirrel August 30, 1911.

An interesting record of the longevity of unengorged nymphs was made in 1910–11. A lot of thirteen nymphs which emerged July 25, 1910, were kept in a small vial covered with gauze in a shed in the Bitter Root Valley. On March 14, 1911, all were alive; July 23, ten were alive and active; August 1, four were alive, one being weak, and all were dead August 7. The last survivors had lived one year and eleven days without food. Several other lots lived almost a year.

As has been mentioned, a lot of engorged nymphs survived the winter of 1910–11. These were engorged between August 22 and September 11. Although kept under rather unnatural conditions, a number of abnormal adults emerged during March, 1911, and twenty-six males and seventeen females, all of which were normal, emerged between July 26 and August 18, 1911. The maximum period from dropping to molting in this series was eleven months and nineteen days. In a large number of records on the molting period of nymphs made in the Bitter Root Valley by one of the authors (King) in 1911, nymphs which dropped, engorged, in April molted from eighty-three to between 130 and 140 days later. Those dropped in May molted within seventy-three to ninety-nine days; those dropped in June molted within thirty-nine to sixty-four days; those dropped in July molted within twenty-nine to sixty-one days, and those dropped in August molted within twenty-seven to thirty-one days. All nymphs which were engorged by us in the Bitter Root Valley during 1911 molted before the coming of cold weather, except a single specimen which was collected on July 4. This had not transformed by October 16 and was not observed afterward. At Dallas, Texas, however, in a lot of nymphs which dropped from a host October 3–6, 1911, three molted to adults the following year. One of these (a male) emerged on May 6, and two (a male and female) emerged shortly before June 8. One nymph in this lot transformed to a male on October 30, 1911, and the others died during the winter. One of those which died remained active for 103 days and another for 136 days after dropping from the host thus showing that transformation proceeded very slowly.

As is to be expected, the longevity of adults is greater in the Bitter Root Valley and other parts of the Northwest where the tick occurs under more natural conditions than at Dallas, Texas, where many of the previously published records on longevity have been made. A series of tests made by one of the authors (King) in the Bitter Root

Valley show that the adults of this tick are capable of a longevity greater than 641 days. This record was made on a lot containing eight males and two females which emerged from the nymphal stage July 9–10, 1910. All of the ticks were alive August 10, 1910, when four males were removed. The remaining four males and two females were still alive April 10, 1912, when the last observation was made. A single male, in another lot containing six males and ten females, which became adult on July 18–19, 1910, was alive on April 10, 1912, when last observed. In another lot consisting of eight females, seven were still alive on the date of last observance, April 10, 1912. In each of the last two lots the longevity exceeded 632 days. In a large series of tests at Dallas, Texas, of adults which molted from nymphs during 1910 and 1911 the longevity of many specimens ranged from nine to fifteen months. It has been found that adults which were collected in Montana in the spring readily attached and became engorged the following spring. These individuals undoubtedly hibernated as adults and were therefore a year and six or seven months old.

Life Cycle

The question of the time required for this tick to complete its life cycle has been considerably discussed. It was thought that one generation developed annually. However, the investigations conducted by the Bureau of Entomology in coöperation with the Montana Experiment Station early indicated that this is not the normal cycle. As pointed out by Cooley[1] and more fully discussed by Hunter and Bishopp,[2] the life cycle often, if not usually, requires two years for its completion. More recently Rucker[3] has made the statement that "Additional experimental evidence seems needful to prove this." The question is not if the life cycle sometimes requires two years, but is it ever completed in one year? In other words, the two-year life cycle is the usual, if not the only course followed by the tick in the Bitter Root Valley. Since it has been proved conclusively by experimentation that adults will not under natural conditions become engorged during the same season in which they transform to that stage, there is no likelihood of the completion of a cycle developing from overwintered nymphs. The same habit prevents the completion of a generation from overwintered larvæ as well as from individuals which may pass the winter as engorged nymphs.

A study of the data on the number of nymphs present on various

[1] Bull. 85, Mont. Exp. Sta., 1911, p. 25.
[2] Bull. 105, Bur. of Ent. U. S. Dept. Agr., 1911, pp. 23–27.
[3] Public Health Repts., Vol. XXVII, No. 36, 1912, p. 13.

host animals examined in 1910–11 in the Bitter Root Valley throws much light on the question of the possibility of a cycle being completed in one year, from overwintered unengorged adults. During 1910, from March 26 to June 30, 393 animals which act as hosts for nymphs were examined and a total of 907 nymphs found, or an average of 2.3 nymphs per animal. From July 1 to August 17 of that year 180 nymph-bearing animals were examined, a total of 300 nymphs being found, or an average of 1.6 per animal. From August 18 to October 14, 127 nymph-bearing animals were examined on which ten nymphs were found, or an average of .07 per animal. During 1911, from April 1 to June 30, 149 nymph-bearing animals were examined upon which 651 nymphs were found, or an average of 4.37 per animal. From July 1 to August 17, fifty-four nymphs were found upon the 129 nymphal hosts examined, or .42 per animal. From August 17 to October 1, one nymph was found on the 33 nymphal hosts examined, or an average of .03 per animal. Supposing these figures to represent the true percentage, it will be seen that 74 per cent of the nymphs which developed during the season of 1910 were to be found on animals prior to July 1, and during 1911, 95 per cent of total development took place prior to that date.

The following will show the bearing of these figures on the life cycle question. In 1910 the first larvæ were taken on hosts on June 13. This was an exceptionally warm season and the appearance of larvæ was probably from one to two weeks earlier than normal. In 1911, a more nearly normal season, the first larvæ were found on July 9. Allowing the shortest possible time for engorgement and molting of the larvæ and the hardening of the resulting nymphs, the date of appearance of the first nymphs of that generation on hosts would be some time after July 1. From this time on, as has been stated, there are very few nymphs on hosts: just at a time when one would expect a heavy infestation, provided it was a normal habit for nymphs developed from overwintered adults to attach the same year. It has also been determined that unengorged nymphs emerging during the fall of one year may live till August 18 of the following year. Hence it is reasonable to suppose that the majority of the few nymphs found on hosts after July 1 are straggling individuals from those which hibernated as unengorged nymphs the previous winter.

August 17 is used as the last date in the second period because of the fact that by this date the principal hosts, the ground squirrel, *Citellus columbianus*, and woodchuck, *Marmota flaviventer*, have gone into hibernation. Then, too, as has been stated, a lot of sixty-seven nymphs which had been placed on hosts on August 17–18, 1910, did not transform to adults till the following summer, hence requiring

more than one year for completing the cycle. It has also been found that nymphs show less inclination to attach to hosts as the temperature declines in the fall.

It must be concluded, therefore, that the possibility of the completion of a cycle in one season is very remote in the Bitter Root Valley. In the more southern range of the tick there is more likelihood of some ticks, which hibernate as adults, being able to complete the cycle in one season. It should also be pointed out that at the rate of development which has been observed in the Bitter Root Valley, it is easily possible for ticks to take three years to complete a cycle.

Results of Tick Attack on Man (Other than Spotted-fever)

A considerable number of curious cases of paralysis, more or less complete and in some cases fatal, have been reported as being produced by *Dermacentor venustus*. Nine cases of this trouble, in each of which a tick (in one case two ticks) was found attached in the hair below the occipital prominence, have been reported to us by Dr. I. U. Temple of Pendleton, Oregon. All of these cases occurred in or near the Wallowa Valley in northern Oregon. A similar case has been reported from Wyoming, and Professor Cooley has heard of one or two cases in Montana. The affliction as reported, first manifests itself as a partial paralysis of the lower limbs, the paralysis advancing to the upper part of the body and arms, ultimately affecting speech, deglutition and respiration. The symptoms subsided rapidly after removal of the tick. The point of attack seems to be an important factor in producing these symptoms. These observations by no means show conclusively that the condition has anything to do with the presence of the tick.[1]

Local, itching sores frequently follow at the point of attachment, especially if infection is introduced by scratching. Swelling of a limb and lameness have been known to persist for weeks following the bite of a spotted-fever tick which was left attached for some time.

Nymphs Attaching to Man

In two instances, one in the Bitter Root Valley and the other in Colorado, a single nymph of this species has been found attached to man. Although this must occur very rarely its importance should not be overlooked, owing to the fact that the nymphs of this species have been shown to be capable of transmitting Rocky Mountain Spotted-fever.

[1] Since this paper was submitted for publication an article by Dr. J. L. Todd (Canad. Med. Journ., Vol. 2, p. 1118-1119) records from British Columbia a number of cases analagous to that described.

It may also be mentioned that a very few specimens of nymphs have been taken on cattle in the Northwestern States.

Practical Application

The recommendations made in Bulletin 105 of the Bureau of Entomology for the control of this tick in the Bitter Root Valley have been strengthened by subsequent investigations. None of the recent findings indicate that any modification of the plan of eradication, as recommended in that publication, is necessary.

It might be mentioned, however, that by taking into consideration the maximum developmental periods and longevity of stages it would not be cause for surprise if living adults, developed from overwintered larvæ or unengorged nymphs, be found in pastures on the fourth spring after beginning dipping or destruction of ticks by other methods on domestic animals. It would be necessary, of course, that small wild animal hosts of the immature stages be present during this time. That this four-year maximum period will ever be attained is a very remote possibility since it has been found that the longevity and vitality of nymphs and adults are lessened if the previous stages (larva and nymph, respectively) are not fed until nearly dead from starvation. Moreover, it is hardly possible for one group of ticks successively to attain the limit of longevity in each stage before finding hosts.

THE POSSIBLE AND PROBABLE ETIOLOGY AND TRANSMISSION OF VERRUGA FEVER

By Charles H. T. Townsend, *Entomologist to the Peruvian Government, Lima, Peru*

Es tierra muy caliente y enferma especialmente de unas verrugas muy enconadas que nacen en el rostro y otros miembros, que tienen muy hondas las raices de peor calidad que las bubas.

—Agustin de Zárate, A.D. 1545.

In certain more or less restricted valleys on the Pacific slope of the central Peruvian Andes there exists today a disease known as verruga. From the earliest times the origin of this disease has been regarded as a mystery. At the time of the arrival of the Spanish conquerors verruga appears to have been much more widespread than at present, extending north into Ecuador. The quotation from Zárate refers to the Ecuadorian coast region. Today verruga is confined, so far as known, to Lima, Ancachs and Libertad departments, between 8° and 13° south latitude.

Dr. David Matto, Editor-in-Chief of the Crónica Médica of Lima, states that verruga has undeniably existed in the quebradas of the Rimac from the most remote times. He argues that the disease was known to the ancient inhabitants of Peru, since the native word "*kceepo*" applied to the verruga warts is distinct in root and meaning

from the Quechua word "*ticti*" applied to ordinary warts. A study of the historical works dealing with Peru at the time of the Spanish conquest indicates that verruga at that time extended from south-central Peru to northern Ecuador in the Andean valleys fronting the Pacific Ocean. The epidemic of disease that decimated the armies of Huayna Capac four centuries ago in this region was probably verruga, so far as can be judged at this date from the descriptions given at the time. This was before the advent of the Spaniards, so that smallpox is excluded. Thus it seems very probable that verruga, like plague, may remain dormant or confined to restricted endemic foci for centuries, and then suddenly, due to unusual sets of conditions, extends itself in epidemic waves causing a widespread desolation of the human race.

The following synonymy of the disease, given by Dr. Ernesto Odriozola, Senior Member of the Lima Faculty of Medicine, in his monograph of verruga published in Paris in 1898, is instructive:

(Fever phase)	(Eruptive phase)
Oroya fever	Blood warts
Carrion's malady or Carrion's grave fever	Soft warts
Verruga or verruga fever	Verruga andicola
Malignant fever of the quebradas	Verruga peruana
Pernicious anemia of the quebradas	Pervuvian warts
Pernicious intermittent malarial fever	Castille verruga
Malarial typhus of Oroya	Mule warts or toad warts
Anemic fever of the quebradas	Quinua warts
Acute wart fever	Bouton des Andes

The following distribution of verruga is taken from Dr. Odriozola's monograph:

Lima Department—Provinces of Yauyos, Huarochirí, Canta and Chancay contain six separate river systems infected, showing seven isolated valleys, with nineteen infected communities, and seven additional known infected but uninhabited localities, the whole ranging from about 2,900 feet to 7,900 feet altitude. The seven uninhabited infected localities known are in the V-shaped verruga district above Lima formed by the Rio Rimac (Rio Cocacharca) and its principal branch the Rio Santa Eulalia; they go by the names of Cupichi, Purhuay, Corcona, Urabamba, Esperanza, Agua de Verrugas (Verrugas Canyon and Verrugas Bridge), and Cuesta Blanca.

Ancachs Department—Provinces of Cajatambo, Huaráz, Huaylas and Pallasca, the last extending into the southern edge of Libertad Department, contain four separate river systems infected, showing eight isolated valleys, with sixteen infected communities, the whole ranging from about 1,300 to 10,900 feet altitude.

Throughout his detailed description of the geographical distribution

of the disease, Dr. Odriozola dwells on the fact that verruga localities are invariably situated either in or adjacent to deep narrow canyons with exuberant vegetation and great summer heat combined with little ventilation. Infected communities not actually situated within such canyons are so close to them that their inhabitants have to pass through them to a greater or less extent.

In July, 1912, Dr. Odriozola summed up briefly, in an address on verruga, certain results that have come to light since the publication of his monograph, from which the following points may be given: A few new verruga localities have been found since, and it is most probable that others still unknown exist, being off the roads of ordinary travel. All the known districts are in or next to deep ravines, where malaria is co-existent with verruga. All ages and races of men are susceptible, and it is also reported that verruga attacks domestic animals. One of the forms of the eruption derives its name mular from the fact that mules often exhibit a similar eruption supposed to be the same. The disease graduates all the way from acute to chronic. It thus presents many forms showing various degrees of virulence. The acute form is the Oroya fever or Carrion's grave fever, which is the most serious form of the disease. Three fundamental clinical characters distinguish it—fever, anemia, prostration. The anemia is always rapid and profound, and its intensity at times is almost incredible, in some cases the erythrocytes being reduced to 800,000 and even as low as 500,000 per cubic millimeter. At the same time the white corpuscles increase inversely. Patient becomes absolutely indifferent and immovable, in extreme cases even a slight movement of the head on the pillow being sufficient to produce vertigo. Diarrhœa is frequent but not always present; usually present in intense cases, at time becoming dysenteric and of inexorable tenacity. The high fever may last from fifteen to thirty days if death does not ensue; after that it begins to lower and the eruptive phase begins. The eruption is of the miliar type, appearing as minute elevations of the skin, pallid or roseate but sometimes intensely red. If the eruption is abundant and generalized, showing vigorously, then the patient is certain to recover.

The chronic form comprises the great mass of the cases, in which there is fever but not of the acute type above described. The fever here may be intermittent or remittent, pains in the joints are dominant especially in the hands and feet, the joints may swell and inflame, and anemia is present. The eruption is the culminating phase in both forms and takes various types, the miliar already described, the nodular of small to large knots or nodules, the mular as an enlarged type of nodular origin, and the pseudomular as an enlarged type of miliar origin.

Between these are various intergrades. The miliar class or type pertains usually to the acute form of the disease, while the nodular class or type is more distinctive of the chronic form; but numerous cases graduate from acute to chronic so that it is difficult to classify them. After a variable but always long duration, often of months, the eruption begins to decrease, loses its color, hardens, becomes encrusted, and finally sloughs without leaving any scar in the case of the true miliar and nodular types; but the enlarged types, mular and pseudomular, leave a whitish or pigmented mark on sloughing. The mular may attain such dimensions as to break of its own weight, admit germs, suppurate or ulcerate.

The only bodies yet found in the blood that can possibly be connected with verruga are Barton's *x*-bodies, discovered by Dr. A. L. Barton, of Lima. Dr. S. T. Darling, Chief of the Ancon Hospital Laboratory of the Canal Zone, has given a good account of them in the *Journal of the American Medical Association* for December 23, 1911, from which the following points may be taken: They are endoglobular and seen first as slender rod-like forms with rounded free ends, but cannot be detected in the fresh blood; thus their refractive index must coincide with that of the erythrocyte. The rods are occasionally single, oftener two or more up to six or eight and frequently grouped in parallel series. Some show filaments or irregularly disposed branches or pseudobranches. They stain dark blue or purple and never faintly blue with chromatin differentiation. After a few days they lose the slender form, swell irregularly, distort and become fragmented. If the disease progresses favorably the *x*-bodies disappear and the eruption comes out. Should the *x*-bodies reappear in their slender form and continue in large number in the peripheral blood, the patient dies. In all cases, according to Barton, the recovery of the patient coincides with disappearance of these *x*-bodies from the peripheral blood.

The following points were furnished me by Mr. A. J. Norris, Chief Consulting Engineer to the Peruvian Corporation: In 1909 a bridge gang of thirty North Americans was taken to Purhuay for work on the Central railway. Their camps and beds were all new and clean. They had no occasion to dig up the soil, being engaged in bridge work, and had practically no occasion to get into the herbage or other vegetation along the river bed. Within hardly more than a week twenty-nine of the thirty contracted verruga fever. The camp was then changed to Chosica, which is just below the edge of the verruga district, and new men were put on the Purhuay work but camped at Chosica, returning there every evening for the night. No cases appeared among these new men.

In 1906, at San Bartólome, which is in the verruga district on the

Central railway, 2,000 men were employed in tunnel work during the year. Among these there occurred 200 known deaths from verruga, and it is practically certain that still further deaths occurred among the many laborers who left the works and whose history was not followed up. The general experience with laborers on the Central railway has been that five or six nights passed successively within the verruga district causes the fever to appear in 75 per cent to 80 per cent of the workmen in a camp. In a week or so nearly all are certain to contract the disease. No animals of any kind were employed by the laborers in any of this work. Mosquitoes and buffalo gnats in abundance, as well as bedbugs and fleas, occur at Chosica and throughout the greater part of the verruga districts.

During the early stages of the work in the building of the Central or Oroya railway up to 1876, when the road was completed into Chicla, thousands and tens of thousands of laborers were employed, largely strong healthy Chileans, as many as 8,000 being carried on the pay-rolls at one time. During this period the recorded mortality from all causes—disease and accident—was some 7,000. A large majority of these deaths was doubtless due to verruga, the result of carrying the road through the verruga district of the Rimac which has given its name to Verrugas Bridge.

After this hurried historical survey of verruga we may proceed to make certain deductions from the data at hand, which may throw some light on the etiology and transmission of the disease. It seems practically proved that Oroya or quebrada fever and verruga eruption are the same disease. The history of the case of the American engineer Wilson who contracted the fever in the seventies of the past century and developed the eruption after returning to North America, indicated the identity of the two, and this was verified by Carrion's experiment upon himself in the eighties. Carrion produced the fever in himself by inoculation, after the manner of a vaccination, with blood from a verruga tumor. This experiment, which unfortunately terminated fatally, not only clinched the etiological identity of the fever and eruption phases, but also demonstrated that the disease is transmissable by inoculation.

The apparently established inoculability of the disease is the basis on which rests the arthropod-transmission theory. Dr. Julián Arce, of the National Academy of Medicine at Lima, was the first to suggest that verruga may be contracted through the agency of some animal bloodsucker. Later Dr. Darling, in the paper above mentioned, suggested "a tick or mosquito, or other suctorial invertebrate having a peculiar altitudinal distribution" as the carrier of verruga. It is well known that the disease can not be transmitted by mere contact as long

as the skin remains whole, nor can it be contracted through either the respiratory or alimentary tracts under normal conditions. It is a blood disease characterized by a breaking down of the erythrocytes, and like all other diseases of this class can be transmitted only by direct inoculation of blood or other vehicle containing its causative organisms in the infective stage. The only way for such inoculation to take place naturally is through the bites of bloodsucking arthropods. It is further proved that it can not be transmitted to man or other mammals by inoculation of blood taken from a verruga subject while in the fever phase of the disease.

The almost exhaustive hæmatological studies of verruga made during the past thirty years in Peru and elsewhere have as yet failed to reveal the causative organism of the disease. Barton's *x*-bodies, first described by Barton in 1905, are unquestionably directly related to the fever phase of the disease. They are uniformly absent during the eruptive phase, and uniformly present in the peripheral blood during the fever phase. They seem most likely to be a form of basophilia caused by a non-infective stage of the pathogenic organism of verruga, which organism is perhaps ultramicroscopic in all its stages and has thereby successfully eluded observation to date. This causative organism evidently reaches the infective stage only at the end of the fever phase or inception of the eruptive phase, and probably remains infective during the persistence of the latter.

The initial stage of Barton's *x*-bodies known by its slender rod-like form, would indicate the beginning of the attack of the pathogenic organism on the erythrocyte. The pyknotic and polymorphous stages would show the successive changes that take place in the erythrocyte during the progress of the attack, which finally results in the destruction of the erythrocytes affected. Cultures made from erythrocytes containing these *x*-bodies fail to produce verruga on inoculation. The natural deduction is that these bodies are the visible results of a non-infective stage of the organism, which metamorphoses to the infective stage in the subcutaneous tissues thereby giving rise to the eruption.

The transmission of verruga by bloodsucking arthropods being almost certainly indicated, the next important point is to know whether or not man is the primary reservoir of infection. This can be quite definitely answered in the negative. The fact that verruga can be contracted in localities uninhabited by man shows that the native fauna constitutes the primary reservoir. This is also unmistakably indicated by the restricted range of the disease. All bloodsucker-transmitted diseases whose primary reservoir lies in the native fauna are originally restricted to the range of that fauna or the portion of it infected. If their transmitters are able to spread outside the original

range and maintain themselves on man alone, then man constitutes a secondary reservoir to be feared, for the disease is bound to spread wherever the transmitter is able to carry it and maintain itself. This is the case with plague, which is transmitted from man to man by fleas that can maintain themselves on man. If, as is probable, the native fauna of any country ever constituted the primary reservoir of yellow fever and malaria, the fact is of little practical importance today, since infected man is now the prevalent and effective reservoir, whether primary or secondary, of these diseases, which are able to spread and become epidemic wherever their mosquito-transmitters can maintain themselves and infected subjects are present.

The fact that verruga is not spread throughout the coast region of Peru by the eruptive phase cases of the disease that are continually arriving therein from the verruga districts indicates beyond doubt that neither the fleas nor the mosquitoes of the coast region are able to transmit it. There are no mosquitoes nor fleas in the verruga districts that can not maintain themselves equally as well in certain similar districts known to be uninfected. There seems to be no reason why the native reservoir fauna of the verruga districts should not maintain itself in certain similar districts at present not infected. There is a possibility that both the reservoir fauna and the transmitter exist outside the actual verruga districts, but that the reservoir fauna is infected at present only in those particular districts. In this case, however, the transmitter must be such that its infected individuals can not spread, either on man or independently of him, from one similar district to another, for otherwise it would infect either man or the reservoir fauna, or both, in the uninfected districts invaded by it.

Fleas and mosquitoes can and undoubtedly do spread between these very similar deep-quebrada districts of the western Andean slopes and foothills, and they are therefore excluded as possible transmitters of verruga, for the disease does not spread with them. Buffalo gnats, horse flies, stable flies, and all other bloodsucking Diptera are likewise apparently to be excluded for the same reason. There are no dipterous forms present in the region that can in any way be likened to the tsetse flies with their local and zonal distribution dependent on presence of suitable conditions for their development. The conditions that exist in actually infected verruga districts are practically duplicated in many uninfected districts easily accessible to all bloodsucking dipterous forms present in the former.

Bedbugs, lice and all other bloodsucking hexapods are likewise excluded for the same reason as given above, while most of them are further excluded because they do not attack the native fauna. Moreover, all strictly day-biting bloodsuckers of man are excluded, because

it appears certain that the disease is usually contracted in the nighttime. Ticks may bite both day and night. They are not excluded because the infective individuals or adult females are large enough and evident enough to be seen and felt and thus avoided during the daytime or while man is awake, but can bite him for hours at a time while he is asleep. It is to be noted further that verruga may be contracted during various seasons of the year, but its principal season of prevalence is during March and April, about the close of the warm rainy season. This is the time of the year when the adult ticks are washed down the steep slopes by the rains and are thus to be found in the greatest number looking for hosts on which to engorge.

The fact that the verruga districts both descend lower and ascend higher in Ancachs Department than in Lima Department would indicate that neither the transmitter nor the reservoir of verruga is specially restricted or conformable to any particular range of altitude, but rather to the existence of certain conditions, and that both are equally at home in quite low as well as rather high altitudes. Certain ticks have an extensive altitudinal range, as the Rocky Mountain spotted-fever tick, while it is practically certain that no bloodsucking hexapods of the Andean region have such an extended vertical distribution as is covered by the verruga districts. The local differences in vertical range of the disease above pointed out would indicate dependence of the reservoir fauna or of the transmitter on local conditions not connected with altitude, as just hinted, perhaps primarily on the existence of uncultivated areas within each of the separated foci of infection. The eggs of ticks are very susceptible to the direct rays of the hot sun, and this may well account for the absence of verruga in certain districts under cultivation but within the altitudinal range of the disease. No such explanation can be applied in the case of hexapod bloodsuckers occurring in the region in question.

In March and April, 1912, verruga appeared at Matucana with considerable force, this locality being outside and above the infected Rimac district as theretofore known and at an altitude of about 7,800 feet. In certain years there are greater or less extensions of the disease, which seems usually to contract again the following year to its previous bounds. These fluctuations in range are probably only partially if at all dependent on periodic extension and contraction of the native reservoir fauna, carrying with it the transmitter as it advances or recedes and are more likely to be dependent on fluctuating extensions of the transmitter due to some unusual cause. As the Matucana extension took place near the end of the rainy season, it is likely that unusually heavy rains had washed the tick transmitters down the steep slopes of side canyons in the vicinity.

The breaking up of the erythrocytes in verruga is accomplished by an endoglobular activity of the causative organism. The only endoglobular hæmatozoans known to be transmitted by arthropods are *Plasmodium*, *Piroplasma* (*Babesia*), and *Leishmannia*. The pathogenic organism of verruga, if not ultramicroscopic, should be either one of these or a closely allied form. *Spirochæta*, *Trypanosoma* and *Filaria* are exoglobular, and thus excluded. *Plasmodium* is untenable, since it demands a culicid transmitter which is precluded by the conditions. It is impossible for a mosquito to have such a peculiar range as that indicated by the limiting boundaries of the verruga districts. The limits of these districts do not conform to limiting lines of any known mosquito environment, and the same may be said with regard to the environment of practically all other hexapod bloodsuckers of the region. *Leishmannia* is excluded as quite certainly transmitted by hexapods only. *Piroplasma* only remains, and it is especially concerned in tick-borne diseases. All the species of *Piroplasma* known are transmitted by ixodid ticks, and by these only. Thus, unless the pathogenic organism of verruga be ultramicroscopic throughout all its stages, which it can hardly be, it is probably a form allied to Piroplasma.

In this connection it is significant that the various species of Piroplasma known to be transmitted by ticks and to produce piroplasmosis in its various forms have never been unmistakably identified in the bodies of the ticks, though indeterminate bodies have been seen by Koch and other investigators. Is it not possible that Piroplasma or some of its near allies pass an ultramicroscopic stage as sporozoites in the tick? Ricketts found that the pathogenic organism of Rocky Mountain spotted-fever exists in the gut, salivary glands and ovaries of the tick which transmits the disease, and further that it appears to proliferate in the tick. The amount of blood that one of the ticks could hold was found to produce only a mild case of the disease on being artificially injected, while the tick could produce several severe cases from one filling of blood. Inoculations from the salivary glands of the infected ticks produced the disease. Yet the organism itself is not thus far known. Ricketts found that fresh defibrinated blood, washed erythrocytes, and unfiltered serum produced the disease on injection, but filtered serum gave no result. Thus the pathogenic organism of Rocky Mountain spotted-fever appears to be non-filterable, but it is nevertheless apparently ultramicroscopic in its infective stage. Spencer claimed to have found ovoid intracorpuscular bodies showing amœboid movement, but his results are doubtful. Ricketts found what seemed to be an organism in the blood of infected guinea pigs and monkeys, to a less extent in the blood of infected man, and also in the bodies and eggs of infected ticks. This supposed organism is very likely a parallel to Barton's *x*-bodies of verruga.

The close parallelism existing between verruga and Rocky Mountain spotted-fever is especially significant. It is possible that both diseases are either ordinary or bizarre forms of piroplasmosis. Both are almost certainly caused by endoglobular hæmatozoans; both consist of a breaking up of the erythrocytes during the fever phase, with resultant anemia; both begin with a very variable fever phase and later develop profound dermatic disorganization; both are confined to certain restricted valleys in the mountainous regions of America; both exist through a wide range of altitude; both exhibit many graduated forms and degrees of virulence; both cause swelling and congestion of the spleen and liver; both may be contracted in localities uninhabited by man; both have their primary reservoir of infection in the native fauna; the specific pathogenic agent of neither is yet known, but indications in both point to a sporozoan allied to Piroplasma; both are almost certainly transmitted only by ticks.

It seems strongly indicated that verruga is transmitted by ticks in practically the same manner as is Rocky Mountain spotted-fever—that is to say, that the early stages of the tick live upon the small native mammals, while the adults attach to large animals and man for engorgement during which process they transmit the disease. This explains the mular eruption in mules in the verruga districts. The native reservoir fauna should be largely immune to the disease but carries in its blood from one generation to the next the pathogenic organism of verruga in its infective sporozoite stage. Immunity seems to be transmitted through only one generation, the third generation becoming again susceptible. The sporozoite is unable to develop at all in the native immunes, their erythrocytes being proof against its attack. It is able to develop and reproduce asexually in the erythrocytes of susceptible animals, and later to reproduce sexually in their subcutaneous tissues where it inaugurates the requisite environment. When the ultramicroscopic infective sporozoite stage of the pathogenic organism escapes in the ingested blood from the immune animals to the gut of the tick, it evidently leaves the gut and lodges in both the salivary glands and the ovaries, where it awaits unchanged an opportunity to gain access to the blood of a susceptible animal. From the salivary glands it escapes during the bite of the tick. From the ovaries it is transmitted in the ova to the succeeding generation of young ticks, in which it takes up its position in the salivary glands. It is reasonable to suppose that it always seeks the salivary glands in immature ticks and adults not yet fully engorged, but seeks the ovaries in fully engorged females which have no further occasion to feed. It evidently remains unchanged in the salivary glands through the transformation of the tick to adult stage, awaiting the engorgement of the adult to gain access to susceptible blood. Mules are evidently more or less

susceptible to the disease, hence the appearance of the eruption in these animals.

This hypothesis explains why verruga is not produced by inoculation of blood taken from patients in the fever phase of the disease; why it is produced by inoculation of blood and serum taken from the eruption; why mules show the eruption; why the native fauna is able to carry the disease without showing any evidences of it; why the fever and eruption take place in man and susceptible animals; why the pathogenic organisms of verruga and Rocky Mountain spotted-fever have not been seen in the blood; why ticks are necessary for the natural transmission of both diseases; why the pathogenic organism exists in the gut, salivary glands and ovaries of the tick, but is never seen in them; why some eggs deposited by a tick may be infected while others in the same lot are uninfected; why the pathogenic organism appears to proliferate or gain strength or number in the tick; why the bite of the adult tick from one filling of blood may produce several severe cases of the disease, while the same quantity of blood that the tick can hold artificially injected produces only a mild case; why the different degrees of virulence occur in both diseases; why the adult ticks are infective, and why the nymphs may have the infective stage of the organism in their salivary glands; why the ultramicroscopic primary stage of the organism is the only infective stage; why the organism does not transform in the tick; why it reproduces in the eruption of susceptible animals; why it enters the ovaries and eggs of the tick when the latter has become fully engorged; why one attack of either disease renders the subject immune; why both diseases are transmissable through the placenta to the second generation; why Rocky Mountain spotted-fever is not inoculable from guinea pig to guinea pig in successive generations, and why it is so by alternation between monkey and guinea pig. The same reasoning seems to apply equally throughout to the pathogenic organisms of verruga and Rocky Mountain spotted-fever.

As a working hypothesis we may thus infer that the ultramicroscopic infective primary or sporozoite stage of the pathogenic organism of verruga occurs in the ticks, in the verruga eruptions of susceptible animals, and in the blood of immunes. It probably undergoes development only in the blood of susceptible animals, and not in the ticks, and with equal probability it reproduces only in the eruption of susceptible animals. During its development through the trophozoite to the merozoite stage in susceptible blood, it is non-infective. After conjugation of the sexual elements in the dermatic tissues, the infective sporozoite progeny appears which needs new susceptible blood for its development. When a patient recovers from verruga and the eruption has finally sloughed, he has become immune to the disease.

It is further almost certain that, like the immune native reservoir fauna, he carries the infective sporozoite stage of the organism in his blood. This would explain what becomes of the pathogenic organism, so far as its continuous life-cycle is concerned, after it has reproduced sexually in the subcutaneous tissues of the susceptible animal. Having reproduced by conjugation in the eruption, the greatly multiplied number of resulting sporozoites invades the blood of the subject, which being now immune does not afford them the environment requisite to their development. The sporozoites must remain quiescent in the same infective stage awaiting the opportunity to transfer to susceptible blood. Thus immune man and mules may constitute a secondary reservoir of verruga—or immune dogs or other animals—but in any event the particular tick which acts as transmitter of the disease is necessary as the medium through which the sporozoites may, during the bite of the tick or during the bites of its progeny, gain access to the blood of susceptible subjects.

The difference in degree of virulence of both verruga and Rocky Mountain spotted-fever exhibited by different cases is probably directly due to the relative numbers of the infective sporozoite-stage organisms which gain access to the patient during the bite of the tick. The tick acts as a collector and reservoir of these sporozoites or infective organisms which become stored in its salivary glands. The number of these that gain access to the blood of a susceptible subject during the bite of the tick is directly dependent on the length of time that the tick remains attached. It was found that the minimum duration of attachment of an infective tick required to produce Rocky Mountain spotted-fever in a guinea pig was one and three-quarters hours. The average was found to be about ten hours, while twenty hours of attachment were almost invariably effective. Thus a short duration of the bite will produce a milder case in both diseases than double that duration by the same infective tick. The patient may be bitten by several infective ticks at different intervals, in which case each successive biting is certain to increase the number of the infective organisms in his blood. It is thus seen that variation in the number of infective ticks and in the duration of their attachment may produce all the known classes of verruga cases with their numerous intergrades.

In the uninhabited verruga districts there are few or no large animals for the adult ticks to engorge upon. Probably these ticks drop from the small native mammals as nymphs and change to adults on the ground, after which they crawl everywhere looking for large hosts. The small uninhabited tributary canyons which exist everywhere throughout the region, like the Agua de Verrugas canyon crossed by the famed Verrugas Bridge of the Central railway, almost certainly keep the disease alive and feed it constantly into the main canyons

and valleys. This may be done more or less by man and animals on the trails passing the embouchures of these tributary quebradas and canyons, the ticks becoming attached to their bodies or clothing. Almost certainly great numbers of the infective adult ticks are washed down the very steep inclines of these tributary quebradas during the rainy season, and spread themselves over the surrounding areas in their search for large animals on which to engorge. It is well known that the newly transformed adult ticks will live for as long as a year without food if they do not find a host in the meantime. Thus man and animals passing the mouths of these tributary canyons are apt to gather these ticks unawares, and man is especially apt to be bitten by them for hours at a time if he sleeps many consecutive nights in such localities. The long life of the infective adult ticks, provided they do not find a host, explains why verruga may be contracted at various times of the year quite irrespective of seasons but in more or less isolated cases. The March and April season of high prevalence of verruga is probably due to the large numbers of ticks washed down during the rainy season in the hills. An unusually rainy season, or a season in which there is greater precipitation during a given time, causing swifter freshets which reach farther than usual, may be responsible for the occasional extensions of the disease which have been noted, as for instance, the Matucana occurrence of 1912. There are doubtless many areas still unknown where the reservoir fauna breeds and the tick transmitters are to be found on the ground in large numbers.

Judging from the probabilities, it is therefore advisable to use much caution in order to avoid the attachment to the person of ticks of whatever kind throughout the western face of the central Andean region below 11,000 feet. Any ticks of the genus *Dermacentor* to be found on the ground or on large animals in this region may be infected with verruga. Those already attached to large animals will hardly leave them of their own accord for man, but those on the ground that are still searching for hosts are particularly to be feared. The danger is always greatest at night, while man is asleep, for their attachment does not wake him and is therefore not felt. Two species of ticks, *Margaropus australis* from the bodies of cattle, and *Ornithodoros megnini* from the ears of horses, cattle and sheep, have been taken by me in the Chosica region, but neither one has any relation to verruga. Both pass all stages including engorgement on the same host. It is the ticks which drop from the small hosts in the nymph stage and seek new hosts in the adult stage that are to be guarded against as possible verruga carriers. These may belong to any one of the genera *Dermacentor*, *Rhipicephalus*, *Hæmaphysalis*, and *Amblyomma*, one or more species of all of which are known to drop to the ground for both moults.

As to the possible identity of the native fauna which constitutes

the primary reservoir of verruga, certain of the native rats and mice or other small rodents are most strongly indicated. The rice rats, comprising many species of *Oryzomys*, are common throughout South America and well represented in the whole coast region of Peru; they are probably not concerned in verruga transmission at present, though there is a possibility that they might become so under extraordinary conditions. The *Octodontidæ* and especially the *Cricetinæ*, relatives of the pocket mice and grasshopper mice, are very abundant in forms in the Andean region, and it seems most probable that among them is to be found the primary reservoir of verruga.

NOTE.—Since writing the above, two important points with reference to verruga have come to light. The Magdalena quebrada, in the department of Cajamarca, has very recently been found to be a strong focus of verruga. Various other localities that have been discovered since the publication of Dr. Odriozola's monograph show verruga to be present at this date in the departments of Lima, Ancachs, Libertad, Lambayeque, Cajamarca, probably the southeastern corner of Piura, and perhaps the southwestern part of Amazonas, extending the known present range northward to 6° south latitude.

The other point is that Drs. Júlio C. Gastiaburú and Raul Rebagliati, of the Lima Institute of Hygiene, have recently found in the eruption of verruga and in the liver of verruga patients in the eruptive phase certain bodies, at times endoglobular, in leucocytes and certain cells, at other times free, which by their staining reaction and morphological aspect seem to them to resemble organisms of the genus *Leishmannia*. It is possible that these are the ookinete stage of the pathogenic organism before it has given off the numerous ultramicroscopic infective sporozoite-stage organisms.

The same authors have found also certain new endoglobular bodies in successive degrees of segmentation which they consider to be remnants of nuclear disorganization of the erythrocyte, and which suggest to them that Barton's *x*-bodies may be chromatin filaments segregated from the nuclei of the erythroblasts. It is probable that these endoglobular *x*-bodies of the erythrocytes, including Barton's *x*-bodies, are the results of the disorganization of the erythrocyte by the invisible non-infective trophozoite stage of the pathogenic organism, during its development to the merozoite stage. The merozoites evidently do not attack new erythrocytes, but as soon as produced they congregate in the subcutaneous tissues. Here some of them develop to male and female gametocytes, from the conjugation of whose elements the ookinete is formed. The plan of life-cycle and reproductive habit here suggested for the pathogenic organisms of both verruga and Rocky Mountain spotted-fever are, of course, purely hypothetical,

but they appear to furnish the only logical explanation of all the phenomena exhibited by both diseases.

PECULIAR EFFECTS OF THE STING OF A WASP

By Arthur H. Rosenfeld and T. C. Barber, *Tucumán, Argentina*

In the early morning of the 23d of October last, we were called to the bedside of a gentleman who stated that he had been bitten by some insect. We arrived at his room about twenty minutes after he had felt the puncture. He told us that he had awakened feeling something crawling on his face, and when he attempted to brush it off the creature had bitten or stung him twice just below the eye. He stated that he could distinctly feel the injected substance going through his veins, and his assertions were confirmed by the fact that, although it was then less than half an hour from the time of puncture, almost his entire body had turned red, and in many parts, particularly on the back and on the arms, there was a breaking out having the appearance of prickly heat. The gentleman was undergoing great pain as the irritation all over the body was very intense. The skin below the eye had already swollen, so that this organ was almost closed, and both arms, particularly around the wrists, had swollen considerably.

A careful examination of the bed revealed a large black spider, but this was thoroughly confined inside of a mosquito bar which had not been used that night. The only other insect which could be found in the room was a partly crushed wasp, apparently of the genus *Tachytes*, which was resting on a hanging part of the mosquito bar, close to the sufferer's head. It appeared that this must have undoubtedly been the insect which had done the damage. It is more than probable that, after the first sting, or during the progress of the second, the insect was struck, thus forcing an undue amount of formic acid amongst the delicate nerves below the eye. The intense irritation passed off in about an hour, although, naturally, the side of the face which had been stung was severely swollen for several days.

The results of this sting were so peculiar that we have thought it worth while to put them on record, and we should appreciate hearing from anyone else who has seen similar effects from the same cause.

N.B.—A few days after this was written a little native girl, about twelve years of age, was stung by a wasp from the same nest. This sting was on the lip. Within a short while both limbs had swelled so that she could not stand, but all effect had worn off by the next morning except immediately in the vicinity of the sting. A few days afterwards a young man was stung on the wrist, his arm swelling painfully to the shoulder. The irritation disappeared shortly as with the other cases.

SOME EXPERIMENTS WITH ROËNTGEN RAYS UPON THE CIGARETTE BEETLE, LASIODERMA SERRICORNE FABR.

By A. C. Morgan and G. A. Runner, *Bureau of Entomology, U. S. Department of Agriculture*

In the Journal of Economic Entomology, Vol. 5, No. 2, pp. 189–192, Mr. W. D. Hunter brought the subject of the effect of the Roëntgen rays upon insects up to date, and discussed a large number of experiments that were performed under his immediate direction. He concluded that there was no indication that X-rays had any effect upon insects.

In the fall of 1912, in pursuance with instructions from Mr. Hunter, the writers proceeded to Tampa, Fla., to test an X-ray machine built for "sterilizing" cigars upon a commercial scale. The promoters claimed that this treatment would either kill or render harmless, all stages of the cigarette beetle, that is, eggs would fail to hatch, larvæ and pupæ would cease to develop, and adults would lay sterile eggs. Since it was possible to give somewhat longer exposures with the Tampa machine than it was found possible to secure with the apparatus at Mr. Hunter's command, and since the cigarette beetle was not included among the species treated by Mr. Hunter, it is thought that a brief discussion of the Tampa experiments might be of interest to this Association.

Briefly, the machine and the method of treatment may be described as follows: The machine consisted of an alternating current transformer with a mechanical rectifier; the rectifier is so adjusted that only the peaks of the rectified waves are taken off the commutator and put through the X-ray tubes. Therefore, the rays produced were of high penetration but of comparatively low burning power, that is, there was a minimum of the Gamma, or burning ray. Two 7-inch X-ray tubes of the self-regulating type are mounted in the leaded exposure chamber. This chamber is six feet long, about two and a half feet broad and two feet high; each tube is placed near opposite corners of the box, about twenty inches from the ends and about eleven inches above the belt carrier. During a commercial run the carrier would move a box of cigars through the field of the rays in nine minutes. The capacity of the machine is about 40,000 cigars a day.

The tubes are customarily started "hard" (*i. e.*, with great resistance), so they will back up a spark gap of 4 to 4½ inches which is equivalent to a voltage of from 64,000 to 70,000. The commercial current passed through the tubes ranged from 1½ to 2½ milliamperes,

at which rate the tubes could be used about thirty minutes continuously. When the amperage is increased the tubes heat up quickly and must be changed. Changing and regulating the tubes consumes so much time that more frequent changes than every half-hour cannot be considered in commercial work.

During our experiments the machine was tested at the commercial adjustment, and afterward the most severe exposures were given of which the machine was capable. Tubes were run both "hard" and "soft," the time of exposure varied from a few seconds to one hour, the voltage from 30,000 to about 75,000 and the amperage from 1½ milliamperes to 14 milliamperes, except in one experiment when the amperage reached 20 milliamperes for 30 seconds. In most instances instead of moving the material through the cabinet upon the carrier, it was placed the closest possible to one of the targets or at the common focus of the two targets.

The following is a brief resumé of the experiments in tabular form:

TABLE SHOWING DETAILS OF X-RAY EXPERIMENTS UPON *LASIODERMA SERRICORNE* FABR., AT TAMPA, FLA.

No. of experiment	Parallel spark gap	Current (milliamperes)	Distance from target in inches	Exposure		Stages exposed
				date	time	
1		2½	10½	Oct. 5	9 min.	adults, eggs, larvæ
2		*	10½	Oct. 5	**	adults, eggs, larvæ
3	4½	1½–2½	12–30	Oct. 7	11 min.	adults, eggs, larvæ
4		12–14	10½	Oct. 8	1 min.	eggs, larvæ, pupæ
5	4½	1½–1½	10½	Oct. 10	10 min.	eggs
6	4½	1½	10½	Oct. 10	30 min.	eggs
7	3½	3	10½	Oct. 10	10 min.	eggs
8	4½	3	10½	Oct. 10	30 min.	eggs
9		3½	10½	Oct. 10	50 sec.	eggs
10	1½	2½	16½	Oct. 15	10 min.	all stages
11	2½	2–2½	16½	Oct. 17	30 min.	all stages
12	3½	2–2½	16½	Oct. 23	20 min.	all stages
13	3½	2½ & 2½	16½	Oct. 25	15 min.	all stages
14	3½	2½–3	10½	Oct. 26	2½ min.	all stages
16	3½–4½	2	10½	Nov. 6	30 min.	adults, larvæ, eggs
17	3½	2	10½	Nov. 9	1 hour	all stages

* The exposure in No. 2 was, 5 min. at 8 milliamperes, 1 min. at 9 milliamperes, 30 secs. at 20 milliamperes and 3 min. at from 1½ to 2½ milliamperes.

** The total time in No. 2 was 9½ minutes.

General results of the above experiments:—the life history of the treated material in every experiment proceeded normally as in the check. Results were, therefore, negative.

A detailed discussion of two of the experiments will serve to indicate the results obtained in all. Experiment No. 3. The following material was used: eggs deposited the night of October 6, 20 larvæ and

10 adults, the exposure was made October 7. All material was placed in pill boxes, cigar box lids were placed over the boxes instead of the regular lids. The boxes were placed upon the belt carrier and were run through the rays in eleven minutes. Minimum distance from the target eleven inches, maximum distance about thirty inches. Parallel spark gap 4⅛ inches which was equivalent to about 65,000 volts. Amperage 1¾ to 2½, averaging slightly over two, milliamperes. Results of examinations: October 15 all exposed eggs and all check eggs had hatched. October 17 treated larvæ and check larvæ were pupating. Treated larvæ presented a normal appearance. October 17 only one treated adult alive; also only 1 check adult alive. The treated adults deposited eggs October 9 and 10. Both these lots of eggs had hatched by October 17.

Experiment No. 17. Exposure made November 9. In this experiment five boxes of badly infested plug cut smoking tobacco were exposed to X-rays for one hour. Parallel spark gap five inches at beginning of experiment; average 3¾ inches. Current two milliamperes. One 7-inch tube used. Material exposed was placed directly beneath the tube, distant from target 10½ inches. The tin covers of the tobacco boxes were opened. All stages of the beetle were present. The tobacco was not disturbed, except to open the paper covering over which the lids of the boxes fitted. Directly after exposure, the covers of the boxes were closed and the boxes placed in a tight receptacle so that the beetles could not escape, or further infestation occur from beetles coming in from without. Five boxes of infested tobacco similar to those exposed were prepared in like manner and kept as a check. On November 11, the material was examined and adults, larvæ and pupæ were apparently normal. On November 12 the material was shipped to the laboratory at Clarksville, Tenn., and was placed in a greenhouse soon after arrival. Frequent examinations of this material in the past few weeks have shown that the treated material has been developing normally in every respect, corresponding to the development of the check material. In the treated material, larvæ have continued to pupate, pupæ have become adult, and the newly emerged adults that were isolated have deposited eggs. This material is being kept to observe any possible effect upon the second generation.

The experiments just discussed were performed upon the commercial machine which produced rays of high penetration but very few of the Gamma, or burning rays. In order to test the effects of the Gamma rays, Experiment No. 14, was performed upon a therapeutic machine consisting of a coil, a chemical interrupter, and an electrolytic rectifier. This form of rectifier, instead of changing

the direction of half the alternating waves, simply prevents the passage of the waves in one direction, allowing the passage of the entire wave in the direction desired, only half the energy put into the transformer being passed through the tube. As a matter of fact, in making this experiment, it was found that when a current of more than 2½ milliamperes was passed through the rectifier and the X-ray tube, that the rectifier did not act positively and that current was passed through the tube in both directions, setting up a condition commonly called "inverse" by X-ray operators. The machine was adjusted, by the introduction of a spark gap in the circuit, to a point where this "inverse" just disappeared. It may be assumed, therefore, that the entire wave was passed through the tube. In other words, the impulses sent through the tube were complete waves from a point of very low pressure up to the maximum pressure produced by the apparatus, and down again to the point of lowest pressure which would pass through the tube. The tube used in this experiment was quite "soft" or of comparatively low resistance. The X-rays generated were, therefore, of comparatively low penetration, but of great burning power. The material treated was exposed directly to these highly reactive rays, and the effect produced might be expected to be the maximum possible for the "soft" rays from an X-ray tube. One 7-inch tube was used, material was uncovered and placed directly under the tube. Distance from the target 10½ inches, spark gap 3½ inches, milliamperes 2½ to 3, averaging slightly over 2½. Time of exposure 2½ minutes. The time of exposure, owing to the construction of this type of machine, was about the maximum practicable; and to secure this exposure 15-second flashes had to be given with considerable intervals to allow the apparatus to cool. The material used in this experiment (No. 14) was as follows: adults exposed 18, check 23; eggs, exposed 10, check 10; larvæ, exposed 50, check 50; pupæ, exposed 10, check 10. The following gives briefly the results of the examinations: *adults* October 29, three dead, two escaped and thirteen left alive in box of exposed material, eggs had been deposited and these were isolated for further examination; of the check adults, ten were alive and thirteen dead, check adults had also deposited eggs which were isolated. November 8, ten of the exposed adults were still alive while only five were alive in the check. Eggs had been deposited in both boxes. At this examination, eggs taken from boxes of exposed and check adults October 29, were hatching.

Eggs—November 8, eggs were hatching in both the exposed and the check lots.

Larvæ—November 8, both lots of larvæ normal in appearance, two pupæ found in exposed lot and two in check lot. Shortly after

this date the material was moved to Clarksville, Tenn., where the temperature was very much lower than at Tampa. At the present writing, December 27, the remaining larvæ in the exposed and check lots are perfectly normal in appearance and are feeding.

On November 2, nine of the exposed pupæ had become adult, one was crushed during an examination. By November 8, five of the check pupæ had become adult, the other five had died. December 27, eggs deposited by adults developing from exposed pupæ have hatched.

It is evident from the above experiments that neither the "hard" nor the "soft" rays used gave any indications of affecting any of the stages of Lasioderma.

X-rays are known to have a very decided injurious effect upon certain tissues and functions of the higher animals, and it seems strange that this effect should not be noticeable upon insects. Since there are other rays, little understood and little studied—said to be associated with the hard and soft rays, the question naturally arises, would any of these, if properly isolated, produce any effect upon insects.

SOME NOTES ON LAPHYGMA FRUGIPERDA S. AND A. IN PORTO RICO[1]

By Thomas H. Jones, *Assistant Entomologist, Experiment Station, Porto Rico Sugar Producers' Association, Rio Piedras, P. R.*

The so-called "southern grass worm" or "fall army worm," the local Spanish equivalent of which is "el gusano de yerba," is a pest of considerable importance in Porto Rico. Because of this, and because any data concerning this insect will be of timely interest, on account of its unusual abundance in the eastern United States during the past season, the following article has been prepared. This account deals with its occurrence, life history, and enemies in Porto Rico, and includes a short note on an experiment with poisoned bait. There is also appended a brief statement regarding another Noctuid, *Remigia repanda* Fab., since, because the larvæ of this species are sometimes found accompanying those of *Laphygma frugiperda*, it has been necessary, in this article, to include more or less data concerning its occurrence.

This paper is a summary of the field and breeding notes on *La-*

[1] Published by permission of Mr. J. T. Crawley, Director of the Experiment Station of the Porto Rico Sugar Producers' Association.

phygma frugiperda, contained in the files of the Experiment Station of the Porto Rico Sugar Producers' Association at Rio Piedras, P. R. Determination of the two species of moths, *Laphygma frugiperda* and *Remigia repanda*, were made by Dr. H. G. Dyar of the Bureau of Entomology, United States Department of Agriculture.

Distribution in Porto Rico. Adults of *Laphygma frugiperda* have been reared from larvæ collected at Rio Piedras and Arecibo on the north coast and Ponce on the south coast, and from pupæ collected at Mameyes on the north coast. Mr. D. L. Van Dine, entomologist of this station, has observed larvæ on sugar cane in the following additional localities:—Buena Vista and Barceloneta on the north coast, Naguabo on the east coast, and Santa Isabel on the south coast. This list of localities gives a wide distribution around the island, near the coast. Since Dr. Agustin Stahl of Bayamon, Porto Rico, included this insect in his "Fauna de Puerto Rico," published in 1882, over a quarter a of century ago, it is probable that it is generally distributed over the island. The reason why it is recorded by the station, for the most part, from the areas lying near the coast is because cane growing, the industry with which the activities of the station are connected, is generally restricted to those areas.

Food Plants. Sugar cane, "malojillo" (*Panicum barbinode*, a grass occurring naturally in Porto Rico on the low, moist meadows, and grown extensively on such areas as food for stock), corn, and onions, are the plants from which larvæ of *Laphygma frugiperda* have been collected and the adults reared at the station at Rio Piedras. From the first three it has been taken several times, while the one record of the occurrence of the larvæ on onions refers to specimens taken within the leaves of that plant in a small vegetable garden.

From what is known concerning the food habits of the species elsewhere, future investigation will undoubtedly add many more names to this list of Porto Rican food plants.

Records of Injuries and Occurrences. Larvæ of *Laphygma frugiperda* are sometimes very abundant locally in Porto Rico during the wet and slightly cooler fall and winter months. The areas attacked may be on land which neighboring rivers have recently overflowed or they may be on land where such flooding has not occurred. So far as observed, serious injury to sugar cane at such times has been to young cane. An outbreak in which cane areas were involved was noted by Mr. Van Dine at Buena Vista on October 3, 1910, following floods, and injury to cane subsequent to similar conditions occurred at Rio Piedras during January, 1912. On November 23, 1912, larvæ and pupæ were collected from land planted to sugar cane at Mameyes, on a hillside where the "grass worms" had been unusually abundant.

The cane in this field was young plant cane, that is, cane at the beginning of its first year of growth.

The larvæ and pupæ collected at Mameyes on November 23, 1912, were taken from a field containing, it is estimated, twenty-six acres. The leaves of the cane plants over an area of some four acres had been eaten to the midribs by the larvæ of *Laphygma frugiperda* and *Remigia repanda*. The degree of injury to the cane over the remainder of the field, as well as in adjoining fields, varied. Unfortunately, at the time of the writer's visit to this locality, the greater proportion of the destructive brood of "grass worms" had completed their development and pupated. Comparative notes on the abundance of the two species could, therefore, not be made. The leaves of old ratoon cane in a nearby field, the plants being some six or seven feet in height, had also been attacked by "grass worms." The amount of defoliation here did not appear to be as great as on the young cane, though it must be borne in mind that the same amount of defoliation would be more evident on the young cane.

There was a considerable growth of "malojillo" in parts of the fields and in some sections this had been "stripped." It appeared, however, that the degree of injury to the cane in various parts of the attacked areas did not depend upon the presence or absence of grass in those parts.

On January 11, 1912, larvæ of *Laphygma frugiperda* and *Remigia repanda*, the greater proportion full grown, occurred in enormous numbers at Rio Piedras over an area that had been overflowed during the previous month. Part of the section on which they were present was in pasture; the grass growing on the land being largely "malojillo." Part of a field of "malojillo," the crop on which was about three feet high, and part of a field of young sugar cane was also being attacked. The larvæ had "stripped" the grass and cane so that only the grass stems and the stalks and midribs of the cane remained. When seen from a distance, the area was well defined, the difference in color between it and the uninjured vegetation bordering it being well marked.

Injury in the La Plata river valley, following floods that occurred at the same time as did those at Rio Piedras, was reported to Mr. Van Dine by Mr. P. H. Gorman of the Porto Rican-American Tobacco Company. The writer visited the valley on January 23, 1912, but found very few "grass worms," though the results of their feeding on the grass in the valley was just as pronounced as at Rio Piedras, part of the area where they had been so plentiful being some distance above the area previously overflowed. The writer was told that the "worms" had, at one point in the valley, damaged tobacco plants to

some extent. The few larvæ collected on January 23 were those of *Remigia repanda* and an unidentified species, though, from the description of the "worms" that had been so common, it seems probable that larvæ of *Laphygma frugiperda* had, with those of *Remigia repanda*, done practically all the damage.

The "southern grass worm" is sometimes found on young plant sugar cane, working on the opening whorl of leaves. This injury may, apparently, occur on cane planted at any season of the year.

Injury to young seedling canes has been observed at Rio Piedras, the larvæ possibly having originated in the grass used for shade on the boxes in which the seedlings were growing.

Corn growing in Porto Rico is severely attacked by a number of insects and *Laphygma frugiperda* is an important pest of this crop. The injury is largely confined to the inner leaves of the young corn plants, though when the plants are very young the larvæ, of necessity, sometimes work on the outer leaves.

Possible Factors Governing Abundance. Outbreaks of the "southern grass worm" in Porto Rico occur only at certain periods. These outbreaks appear to be governed by climatic conditions; occurring during the fall and winter seasons when there is an abundance of rainfall and when the temperature is somewhat lower than at other seasons. There is, during these seasons, a more abundant growth of grass, which may be favorable for the development of the larvæ because of the abundance of food.

Abundance of larvæ following floods may perhaps be due to the fact that when the rivers recede there is left on the areas, previously covered by the water, more or less additional vegetable débris and soil. This deposited material may contain eggs or larvæ which the surface water from the watersheds of the rivers has brought down and which would, therefore, be concentrated on the overflowed areas when the rivers subsided.

It may be that unsuitable conditions, such as abundance of water, lack of food, or lower temperature, in certain sections, cause the species to seek other areas. If there is a migration, it would be interesting to decide what factor or factors are accountable for the selection of any particular area in which to breed.

In all of Mr. Van Dine's field notes on this species it is stated that the injury to sugar cane was in fields of young plant cane. This appears to be the case both when the larvæ occur in great numbers and when they are present in small numbers, scattered through the fields. This may be due to the fact that, in the vegetation growing on the land, previous to the planting of the cane, were natural food plants of *Laphygma frugiperda*, the species attacking the cane after

the removal of this growth. Generally speaking, grass is more abundant in fields of young plant cane and this may have some connection with the attack on the cane. Larvæ may also invade cane fields from adjoining grass areas, especially when the food supply becomes exhausted.

The larvæ apparently prefer the young cane. Mr. Van Dine states that the severe injury following heavy rains at Buena Vista was confined to the young cane, there being no apparent injury to the more mature cane growing on land that had also been under water. At Mameyes the young cane had apparently been preferred to the older growth. This may be because the larvæ do not naturally seek the higher plants. In an extensive article on this insect, published in 1901, Dr. F. H. Chittenden states, "—these larvæ prefer low growing plants."[1]

There have been remarkably small second broods of larvæ in localities where outbreaks of "grass worms" occurred. At Rio Piedras, although moths from the larvæ of the destructive brood were seen to issue in some numbers, the second brood of larvæ was of small consequence. Neither were there any reports of abundant second broods at other points on the island where similar outbreaks had occurred. This decrease in numbers can be accounted for, in part, by the presence of parasites and predaceous enemies, and cannibalism may play an important part in the reduction of the species on areas where the supply of vegetable food becomes exhausted. One case of cannibalism was noted in the field at Rio Piedras, one Laphygma larva being seen to grasp another and soon disembowel it, both specimens being on the surface of the soil at the time and the attacked larva apparently about to molt. It is also possible that the moths, on issuing, may fly to a considerable distance before depositing their eggs, the result being that the larvæ of the second brood are scattered over a larger area and the results of their feeding not so apparent.

Life History. On April 27, 1912, the writer found a cluster of forty-six eggs of *Laphygma frugiperda* on the upper surface of a leaf of young plant cane at Rio Piedras. The eggs hatched on April 30 and eight of the newly hatched larvæ were placed in separate glass vials, plugged with cotton and containing leaves of "malojillo." The remainder were placed in a battery jar containing moist earth and "malojillo." The contents of the vials were examined from day to day, the grass and excreta being removed and fresh grass introduced. As the larvæ approached maturity they were transferred to glass bottles containing moist earth; leaves of "malojillo" still being given as food. The larvæ in the battery jar were not as closely watched, though they

[1]Bulletin 29, new series, U. S. Dept. of Agric., Div. of Ent., p. 31.

were kept supplied with fresh grass and the earth in the jar was kept moist. Until the third molt the larvæ fed only on one epidermis of the grass, but after that upon the entire blade.

With the exception of one larva, which for some reason did not develop as quickly as the others, all the larvæ entered the soil on May 21. Seven consecutive molts of the head were found in four of the vials and six in the remaining four, the time elapsing between molts ranging from two to four days, and the last molt occurring, on an average, five days before the larva entered the soil. Four of the seven moths obtained from the larvæ originally placed in the vials issued twelve days after the larvæ had entered the soil to pupate. Two remained in the soil eleven days and one thirteen days. On June 3, a day after the majority of these issued, two adults came from the soil in the battery jar. No other specimens were obtained from the jar.

Summarizing, we have, under the breeding-house conditions, and the climatic conditions prevailing at the time, twenty-one days for the larval period and an average of twelve days for the prepupal and pupal stages combined.

From observations made on this insect the writer believes that the time necessary for the completion of its life cycle in Porto Rico varies considerably, this variation depending upon the temperature and moisture conditions. This difference might, perhaps, not be expected, since the temperature conditions, especially on the north coast, are quite equable. Four adults, from larvæ that were collected when very small and cared for in the same way as were those on which the above life history notes were made, issued from the soil in April, sixteen days after the larvæ had gone below the surface. This is a period of four days longer duration than was necessary for the prepupal and pupal stages during the latter part of May of the same year. Other notes show a difference in the length of time consumed in the various stages of development, but unfortunately we have no thermographic or hygrographic records to accompany them.

The breeding records of the station show that adults, from eggs or larvæ collected in the field, have issued at various times during the months of January, February, March, April, July, October and December. Further observation throughout the year will probably show that the larvæ are to be found throughout the twelve months.

ENEMIES. Three species of Tachinid flies have been bred from *Laphygma frugiperda* at the station at Rio Piedras. These have been determined by Mr. W. R. Walton, of the U. S. Bureau of Entomology, as *Frontina archippivora* Will., *Gonia crassicornis* Fabr., and *Archytas piliventris* V. d. W.

Adults of a Carabid beetle, *Calosoma alternans* Fabr. (determined by

Mr. E. A. Schwarz of the U. S. Bureau of Entomology), as well as larvæ, probably of this species, have been taken in areas where the "southern grass worm" was abundant. A single adult of a smaller species of Carabid was reared from a larva taken at Rio Piedras near poisoned bait, where dead larvæ of Laphygma were present.

Lizards probably feed on the larvæ and adults and may be important enemies of the species.

Two species of blackbirds occur in Porto Rico, known locally as "el chango" or "mozambique" (*Holoquiscalus brachipterus*) and "el Judio" (*Crotophaga ani*). Both of these blackbirds undoubtedly do a great deal of good in reducing the numbers of caterpillars, particularly those occurring in the more open grasslands.

Results from the Use of Poisoned Bait. On January 13, 1912, an experiment was made with poisoned bran at Rio Piedras. One-fourth pound of Paris green and ten pounds of bran were mixed and enough water, sweetened with molasses, added to make the particles of the mixture adhere. The compound was placed in small piles on ground, very free from vegetation, between a field of grass, in which the "grass worms" were very plentiful, and a plot of young cane which they were apparently just beginning to attack. Larvæ, largely those of *Laphygma frugiperda*, found dead around the piles on January 16, were referred to Dr. F. W. Zervan, chemist of this station, for analysis, and he later reported that their bodies gave a decided arsenic reaction.

In connection with the outbreak of "grass worms" in the La Plata region, the writer was told that poisoned bait, the composition of which was not learned, distributed in a furrow through a field of grassland, had destroyed larvæ "by the hatful."

A Note on "The Grass Looper," *Remigia repanda* Fab.

Where outbreaks of the "southern grass worm" occur the larvæ are often accompanied by the larvæ of *Remigia repanda*. In the area attacked at Rio Piedras during January, 1912, the larvæ of *Laphygma frugiperda* appeared to predominate, though they did not greatly exceed "the grass looper" in numbers. While the two species occurred together, one or the other prevailed in sections of the whole area. At the other points where outbreaks occurred, no data was obtained on the relative abundance of the two species, the larvæ having, for the most part, pupated at the time visits were made to these areas.

As has been mentioned, the larvæ of *Laphygma frugiperda* prefer to work among the opening leaves of the cane, while those of *Remigia repanda* work upon the unfolded leaves, the older as well as the younger portions of the plants being eaten. When the food supply becomes scanty, however, this difference in feeding habits is less pronounced.

PEACH "STOP BACK" AND TARNISHED PLANT BUG

(*Lygus pratensis* Linn.)

By LEONARD HASEMAN, *Department of Entomology, University of Missouri*

For many years the nurserymen of Missouri as well as those of other states have been confronted with injury to peach and pear buds in the early spring. This injury has been laid to various causes. Some attribute it to the work of thrips, others to mites and in some cases it has been supposed to be due to soil conditions. A number of papers during the past year have appeared in which the relation of the tarnished plant bug to this injury has been carefully discussed. In the writings of some of the earlier entomologists we find brief discussions of the importance of the tarnished plant bug with reference to the destruction of buds and to the injury it does to fruit and plants in general. It is not strange, therefore, that we should suspect this insect and attribute to it at least a part of the injury to peach and pear buds.

For the past two years the writer has been following the injury commonly spoken of as "stop back" of peach here in Missouri and finds that the tarnished plant bug is responsible for this injury. The injury is worse some seasons than others and seems to be worse in certain parts of fields. Invariably it is the more thrifty growing nursery stock which suffers most and this is usually in the damper parts of the nursery blocks and where the soil is richest. During the past spring this injury was probably as noticeable in certain sections of Missouri as it has even been known to be in this state. Some seasons the injury begins to appear soon after the dormant buds in budded peach stock begin to push out but fortunately the past summer it did not occur until the first week in June after the young growth had advanced from eighteen inches to two feet and therefore was not especially destructive, though in some portions of the infested blocks nearly all of the growing buds were killed. This injury occurs all of a sudden and the agent of destruction seemingly disappears from the nursery almost as suddenly.

The study of this pest is being carried on at the Experiment Station and in one of the nurseries of central Missouri. The nurseryman notified the writer on June 7, three or four days after the first severe signs of the pest appeared, and on arriving at the nursery it was found that but few bugs still remained in the nursery, but on visiting adjoining fields of clover, timothy and weeds it was found that they were present in great swarms, especially in clover where they were at work

depositing eggs. The writer learned that with the first appearance of the wilting of the buds these same swarms of tarnished plant bugs were present in the nursery blocks and from this and from later experiments with a view of determining the effect of the feeding of this pest upon peach buds, there can be no doubt but that in Missouri the tarnished plant bug is the source of its injury to young peach buds. The peach twig borer is often very troublesome in Missouri, especially on older trees but very little of its injury occurred in this nursery. The block of peaches found to be worst attacked stood alongside a forty-acre field of clover which was in full bloom when the writer visited the nursery. This clover was cut and cured a week later which evidently destroyed the majority of the eggs deposited by the tarnished plant bugs, for at no time later in the season were they so abundant in this field or in the nursery though in other fields they were plentiful all summer.

The writer has not had any opportunity of making a careful study of the early spring activity and development of this insect, but it would seem that on emerging from its winter quarters the pest is especially fond of the sap of peach and pear, but that after the first brood of eggs are deposited in the spring, the insect, like some of the orchard plant lice, prefers to feed upon the sap of other plants where the eggs are deposited, so that in this latitude at least it seldom returns to the nursery in destructive numbers.

The writer has had an opportunity of following the pest through the late summer and fall months and has learned a number of interesting facts with reference to the insect and its activities during that part of the year. It was found that the tarnished plant bug does not deposit its eggs in the tissue of plants as some maintain, not even in the soft stems of weeds. The ovipositor of the tarnished plant bug does not seem to be sufficiently strong to enable it to drill into tissues of plants. In this region it deposits its eggs, in the fall of the year at least, only in the blossoms of flowers such as daisies, asters, "mare's tail" (*Erigeron canandensis*), etc. This latter weed is used very largely for the depositing of eggs in the fall. The nymphs as well as the adults feed upon the sap of this plant during the months of August, September and October. They continue to breed upon it until the first heavy frosts have completely killed out the plant and driven them into winter quarters. It is not uncommon to find the pest feeding as late as the first of November upon plants in sheltered places. After frosts have destroyed most weeds and other plants one can find the tarnished plant bugs collecting in swarms around gardens, feeding upon the sap of turnips and other plants of this type which are more resistant to frost. During the winter they are

to be found by the thousands in and among the leaves of mullen plants where in this latitude they crawl about on warm days during the winter. Judging from the number of tarnished plant bugs which have gone into winter quarters, we may expect very severe injury to nursery stock in the spring.

A study of the development of the tarnished plant bug during the fall months has proven most interesting. In these studies the writer finds that the pest completes its cycle in thirty to thirty-five days during the months of September and October and he is of the opinion that during the summer months the life cycle is completed in from twenty to twenty-five days. It has been found that the pest has five distinct nymphal stages in place of four, as has always been maintained, therein agreeing with other closely related Hemiptera. It is not strange, that the one nymphal stage has been overlooked by other workers, for it was not until a great many specimens had been followed from the egg through the first three nymphal stages, that the stage which has always been overlooked was finally discovered. The confusion is with the first three nymphal stages. The writer soon found that he had a nymph which in size, shape and markings did not agree either with the newly hatched nymph or the stage figured by other writers as the second nymphal stage. For a time it was considered as the early second stage but when it was found that it molted on assuming the form of the supposed mature second stage, it was clear that this was a distinct stage. This was confirmed over and over later with first stage nymphs. In a number of cases the writer has been able to carry individual specimens of the insect from the freshly laid egg through the five nymphal stages to the adult form. The life cycle and development of the tarnished plant bug will be discussed more in detail in another paper.

The subject of the control of the tarnished plant bug is one that deserves special attention for the injury to nursery stock alone is very considerable each year and the damage to vegetables and small fruits is not to be overlooked. This insect will probably never be controlled by any one method though by resorting to a number of simple methods of insect control it can be kept in check. During the late summer and fall all weeds and other blooming plants which provide a place for oviposition and food for the young and old insects should be carefully destroyed. Fence rows, roadsides and waste lands always furnish breeding grounds for this insect and they should be kept free from weeds, or all infested weeds should be sprayed regularly with a strong contact wash. Hundreds of tarnished plant bugs will mature on a single isolated weed during the summer months. In the winter all harboring places of the hibernating adults should be

burned over and mullen and other partially green plants which harbor the insects should be carefully destroyed. In the spring trap crops can probably be used to advantage in protecting nursery stock though this will require futher investigation. When the adult tarnished plant bugs are at work in the nursery a machine, provided with sticky shields, something similar to the one used for the apple leaf-hopper, is very effective in catching them. They are much more active than the leaf-hopper but where such a machine has been used in a nursery it catches thousands of the tarnished plant bugs. The writer is inclined to doubt the feasibility of protecting peach stock by spraying, at least with any of our present-day insecticides.

THE APPLE LEAF-HOPPER

(*Empoasca mali* LeB.)

By LEONARD HASEMAN, *Department of Entomology, University of Missouri*

To nurserymen growing apple trees on an extensive scale this pest is often one of the most troublesome, especially in the more northern section of the Middle West. It has for years caused great trouble to nurserymen throughout the northern half of Missouri and in the last season or two has shown signs of becoming troublesome in the nurseries, even of the southern part of the state. In those nurseries where it has become established it is exceedingly injurious to the young stock and difficult to control. Aside from reports by Mr. Webster, issued recently by the Agricultural Experiment Stations of Iowa and Minnesota, we have little in the way of definite records concerning this pest, its life cycle and means of controlling it.

For the past two years it has been under observation by the writer in one of the larger nurseries of this state. We have not succeeded in making much progress relative to the life cycle and habits of the pest throughout the summer months, but we have determined some facts and have arrived at a definite scheme which seems to prove entirely effective in keeping the insect under control. We are told that the pest passes the winter in the egg condition under the bark of apple trees in the more northern states. From observations and experiments in Missouri it would seem that the pest is never carried over the winter in this condition, but, similar to the grape leaf-hopper, it passes the winter in the mature stage hiding about rubbish, along fence rows and under the foliage of such plants as docks, turnips and others, the foliage of which is not always completely destroyed by the first frosts of winter. Trees taken from the worst infested

portions of the nursery in which the work is being carried on were planted in breeding cages here at the Experiment Station and in no case were we able to rear leaf-hoppers from these trees. As a further evidence that in Missouri the pest is not carried over in the egg condition, one block which came under the writer's observation consisted of forty or fifty acres of one-year-old apples which had been severely injured two years ago by this pest. The winter of 1911 and 1912 was so severe that these trees were cut back to the ground before spring opened with a view of securing strong, healthy one-year-old trees on two-year roots. In the early spring of 1912 the writer examined this block when the pest first became noticeable throughout the nursery and while this block was several miles from apple orchards and in fact no fruit trees at all were within a mile of the ground, still it was found that these young trees, before they became half a foot tall were badly infested with very young nymphs and mature leaf-hoppers. The block under consideration was surrounded in part by woods and creek bottom land where an abundance of rubbish and leaves were collected in which the pest evidently passed the winter in great abundance and in the spring the adults simply moved back to the young growing trees and started the first colony of young.

The writer finds that in the early spring the first forms to appear are a few scattered adults. Following these is to be found usually a rather heavy brood of the young which are sufficiently abundant to seriously curl the first leaves. In a month to six weeks following this a second colony arrives and in a like period a third and so on until shortly before the leaves begin to fall. The later broods increase in numbers where measures are not taken to check them.

The writer has not been able to determine definitely with reference to the actual number of summer broods, but those which he has followed through seem to require from four to six weeks to complete their growth. In a nursery where the pest is uninterrupted one can usually determine from a single infested tree the number of times at which the heavy broods arrive from the fact that beginning near the ground is to be found a circle of curled leaves followed by fairly healthy foliage, succeeded in turn by another badly curled portion, and so on to the top of the tree.

From observations made before and after the first killing frosts this fall, it has been found that the adults leave the trees and collect along fence rows and in other protected places for the winter. The writer believes this will be found to be true throughout this state at least.

In reference to remedies for the pest it has been found impossible to control it entirely by the application of sprays. After a number of years of experience with spraying operations, the foreman of the

nursery in which the work is being carried on finds that while he has been able, at great expense, to prevent serious injury from the pest, he has not been able to control it completely. In view of the fact that the pest seems to pass the winter in the adult stage and arrives in the nursery to deposit eggs soon after the trees begin to grow, it occurred to the writer that a very thorough application of a contact wash in the spring to destroy the first brood of young might have a far-reaching effect upon the pest later in the season. With this in view a series of experiments with different washes was undertaken and from a comparative test of some eight or ten of these, it was found that the young nymphs could be readily destroyed with an oil wash. One of the commercial brands of miscible oils gave the best results. Probably the same results could be obtained by the use of a home-made kerosene emulsion, but this wash was not included in the comparative test this past spring. The kerosene emulsion has been the standard wash with this nursery firm for a number of years and the foreman found that it did not seem to be quite as effective as the miscible oil.

In order to control this first brood it is necessary to make three or four applications at intervals of from three to six days since the nymphs of the first brood do not appear at the same time. The first brood seems to be drawn out over two or three weeks. After carefully applying contact washes for this brood, spraying operations should be discontinued. The washes under consideration had little or no effect upon the stray adults which were found in the nursery during the application and spraying operations are too expensive to repeat throughout the summer at the necessary intervals to catch the nymphs before they become winged.

Following the early spraying this year a machine was run at intervals of three or four days with a view of catching as many of the winged adults as possible. This trap is built on the sticky shield plan, mounted on wheels and so adjusted as to enclose two rows of trees. The sticky shields extended forward to a point slightly in advance of the horse and are roofed over behind and sufficiently high on either side to prevent the escape of many of the insects. In this way the horse acts as an agitator and the back part of the machine is closed by suspending gunny sacks thereby preventing the escape of any great number of insects in that direction.

In the experiment carried on during the summer it was found that so many of the hoppers, tarnished plant bugs, and other insects of this type were caught upon the sticky surface of the machine that it was usually necessary to scrape and re-paint the machine twice each day

and during each cleaning of the machine from one to two or three gallons of insects would be removed.

This sort of machine can be run at very slight expense and in those blocks where it was run regularly during the summer it was impossible to find any signs of curled leaves due to the injury of the pest. The writer is of the opinion that if three or four applications of contact washes of the oil type are made at intervals of three or four days in the early spring when the first young nymphs appear and then follow this up during the summer with a machine for catching the adults, this pest can be controlled in any nursery at a very reasonable expense.

FALL SPRAYING FOR THE PEAR PSYLLA

By H. E. Hodgkiss, *Geneva, N. Y.*

Life history studies on the pear psylla were continued by the station during the past year for the purpose of determining more efficient methods for the control of this pest, and special attention has been given to the habits of the hibernating adults or "flies." Our investigations have shown that these individuals remain on the fruit spurs and young growth of the trees until the first severe cold weather occurs in November, when they seek the protection of the loose bark of the trunks and larger branches of the trees or hide under leaves or other débris which may be in the orchard. The roughened bark on adjacent trees of other kinds of fruits is often sought by them. If there is a warm spell during the late autumn and winter the "flies" become restive and abandon their sheltered places to gather on the lower branches of the trees, especially on the newer wood and fruit spurs. Whenever the weather moderates to a marked extent few of them remain in hiding, and where severe infestations exist myriads of the tiny insects cluster in the center of the trees. At such times the adults walk, but are sluggish in their movements and rarely attempt to jump or fly. The short duration of sunshine and the daily increasing cold cause a continual lessening of the activities of the insects, which become numbed and cling to the wood for considerable periods of time without exhibiting signs of movement.

The behavior of the hibernating psyllas in the *spring* is quite different from the habits of the insects in the *fall*. With the conclusion of winter the temperatures are constantly increasing and the daily effectiveness of sunlight is correspondingly longer. Coincident with moderation in the weather thousands of them leave their places of concealment and often a few hours of time are sufficient to effect great activity among the pests. It is not uncommon for them to jump and fly directly after emergence from their winter retreats.

The destruction of the hibernating "flies" is an important measure for the protection of pear orchards from psylla attacks. Careful spraying in the spring greatly reduces the numbers of the individuals and in some instances has completely freed plantings from the insects. The activity of the adults at that time has, however, prevented some growers from obtaining full control of this pest. It appears from the work that we have done that, on account of the difference in the behavior of the "flies" to gradually lessening temperatures, more favorable conditions exist in the late autumn for effective spraying.

During 1911 unprecedented numbers of psyllas entered hibernation, which afforded an excellent opportunity for demonstrating the value of fall treatments for the "flies." The experiments commenced on December 6 and continued until December 18, during which period thousands of the insects were clustered on the branches of the trees. The sprays applied were nicotine, fish-oil soap and lime-sulphur solution, used either separately or in combination. Nicotine preparations and soapy solutions were very effective. The lime-sulphur solution at dormant strength did not cause a marked reduction in the numbers of the psyllas, but with the addition of nicotine, the results from the combination compared favorably with the soapy sprays. Less than five per cent of the original infestation remained in the orchard at the completion of the work and in the following spring only scattering "flies" appeared upon the trees. In 1912 orchardists who were usually unable to control them by spring treatments found little difficulty in ridding their orchard of the insects through late fall applications of these sprays.

The success attending the *fall* spraying of pear orchards for the psylla is dependent upon,—(1) an understanding of weather influences upon the activities of the hibernating adults; (2) the complete wetting of each tree as the work proceeds; (3) thorough work in spraying.

THE 1912 OUTBREAK OF ALABAMA ARGILLACEA IN PERU

By Charles H. T. Townsend, *Lima, Peru*

During the first few months of 1912 the cotton leaf-caterpillar multiplied in extraordinary numbers in the cotton districts of the Peruvian coast region from about 9° to nearly 12° south latitude, and more or less unusually and generally to the northward as far as Piura Department. Complete defoliation occurred over the greater part of the districts from Chancay to Casma, reaching the latter valley on March 5. Much interest attaches to this outbreak from the fact that the meteorological conditions of the warm season of 1911–1912 in the coast region of Peru were very unusual.

The ordinary climatic conditions of the central Peruvian coast region from Chancay to Casma, in the low-lying cotton districts just back from the shore line, are as follows: June to November, very humid atmosphere, mist during nights and mornings, more or less continuous cloud-blanket, cool temperature; December to May, less atmospheric humidity in general with an approach to aridity during days, no mist, generally clear sky, warm but not oppressively hot temperature, cool ocean wind from south decreasing largely or dying out during the hottest part of the season.

The season of 1911–1912 showed the following abnormal conditions in this region: Very cloudy weather in general from November to March; an almost constant cloud-blanket from February 14 to 22, practically no sun, great atmospheric humidity with intensely oppressive heat, an unusually strong and very hot south wind continuing throughout the hottest season. This wind was evidently not the usual cool south wind from off the Humboldt ocean current, but a hot land wind from a general southeast direction that had followed up the coast line and whose origin was probably due to extra-local causes. It seems to have been strong enough to divert the south ocean wind from its usual course, or was perhaps itself a diversion of that wind, and was probably therefore responsible for the piling up of the unusual banks of humidity hanging over the coast line in this region.

It seems quite certain that the abnormal degree of humidity, with no sun, that prevailed during the last half of February, stagnated the soil of the irrigated fields by practically preventing the usual evaporation, while the abnormal heat caused a soil fermentation to set in, whereby neither the cotton plants nor the herbage in the fields showed any growth whatever from February 15 to March 21. The cotton plant was thus physiologically inactive for over a month during its usual period of greatest seasonal growth, and therefore still less prepared than ordinarily to withstand the attack of the caterpillar which was at its period of greatest activity. Irrigation during this period had no effect on the cotton plant, but rather made conditions worse.

The nights of March 21 and 22 were cold, with a sea-fog, and immediately after this sudden change in the meteorological conditions the cotton plants began to show signs of renewed activity. The herbage did not appear to resume growth till about March 30.

It seems indicated that the abnormal degrees of both heat and humidity which prevailed especially during February were most favorable to the rapid development of the caterpillar, resulting in an accelerated development of the stages of the insect, whose life-cycle seems to have averaged shorter than usual in North America, being reduced to about four weeks or even somewhat less. Three well-marked generations

were noted from January to March, and another was evident in April in certain districts. Thus there were at least five and perhaps six generations from December to April.

The abnormal fermentation of the soil, which was so pronounced as to sour the air in the fields, not only stopped the activity of the plants but probably killed a large part of the enemies of the caterpillar. The common *Eucelatoria australis*, one of the Compsilurine flies, was found commonly in the fields in April and was reared from the caterpillars. It does not go into the soil for pupation as a rule, while other muscoid species that probably attack the caterpillar enter the soil to pupate and were uncommon in the fields. Every detail of the complex of unusual conditions appears to have been exactly in favor of the caterpillar. The moths appear to have been carried to a considerable extent from one irrigated valley to another by the strong southeast wind already mentioned. The southernmost districts were the first to show decided injury, beginning early in January. The injury spread northward in a wave of increasing intensity during the next two months, while the greatest injury in some of the southernmost districts came later in April.

In the Casma valley, which is in the northern edge of the region of greatest defoliation, the caterpillar was noted as alarmingly abundant in isolated spots in the upper districts about the end of January. Fifteen days later there was a general infestation by spots, and active general defoliation began about the last of February and was completed about March 5. In the lower districts of the Casma valley, unusual multiplication of the caterpillar was not noted till February 9, and defoliation did not become complete. From March 5 to 21 there was practically not a leaf or sign of growth in the defoliated areas.

No arsenates were on hand in any quantity, and by the time the planters awoke generally to the importance of the outbreak, the caterpillar was so far advanced that little could have been done had poisons been available. The American Upland is the variety universally cultivated in all the districts in question, the yield being from 460 to 500 pounds lint cotton per acre. Some of the largest plantations in these valleys lost heavily by the caterpillar, one estimating its loss at £12,000. The Casma valley had about 3,500 to 4,000 acres in cotton, the loss by the caterpillar being over £20,000 on this acreage. The entire loss by the caterpillar in the Chancay to Casma districts, from January to April, is estimated at something over £70,000.

NOTES ON SOME MEXICAN SUGAR CANE INSECTS FROM SANTA LUCRECIA, STATE OF VERA CRUZ, INCLUDING A DESCRIPTION OF THE SUGAR CANE TINGID FROM MEXICO

By F. W. URICH, *Entomologist Board of Agriculture, Trinidad*
and OTTO HEIDEMANN

The sugar plantation on which I spent the months of August, September and October last year is situated about twelve miles from Santa Lucrecia on the Coatzacoalcos River. There are about 3,000 acres of canes under cultivation which were growing in a most luxuriant way and most of which were ratooning for the seventh time. (See Plate 7.) The climate of that part of Mexico was quite tropical and the fauna and flora reminded me often of those of Trinidad and northern South America. On the whole there were few insects that did much damage to the canes, in fact there was only one that called for serious attention and that was the Cercopid, *Tomaspis postica* Walk. It is reported that this insect has been known as a pest to grass lands of the State of Vera Cruz since 1880 and in 1903 was observed attacking sugar cane at Tantoyuca. The natural food plant of *Tomaspis postica* consists of grasses of several species, especially those growing in damp clay soils; from the grass it has spread to canes and there by the combined activity of the nymphs on the roots and the adults on the leaves, causes considerable damage when numerous and unchecked. Luckily it is controlled naturally by a parasitical fungus which also attacks [1]*Tomaspis varia* Fabr. in Trinidad, and which has been determined as *Metarrhizium anisopliæ* Metschnikoff. In some places a species of *Empusa* was also killing a good many of the adults. Unlike Fulgorids these Cercopids do not appear to have any egg parasites or parasites on the nymphs, at least I did not find any and have not been able to discover any records of such. A Reduviid bug, *Castolus plagiaticollis* Stal. (det. Heidemann) was very common in the fields where *T. postica* was numerous and many adults were to be seen carrying around these Cercopids impaled on their proboscis. Unfortunately the eggs of *Castolus* were attacked by a species of *Telenomus* (det. Crawford). The old cane pest, *Diatræa saccharalis*, was not wanting and there was a second stalk borer present which Dr. H. G. Dyar has determined as *Diatræa grandiosella* Dyar. It cannot be said that either of these were very serious pests. It was not an easy matter to find egg masses of these moths in the

[1] In my "Notes on some insect pests affecting the sugar cane" Journal of Ec. Ent. Vol. 4, p. 225, I refer wrongly to this insect as *T. postica*.

cane fields, but the only two that were found were parasitized; *D. saccharalis* by *Trichogramma pretiosa* Riley (det. Howard) and *D. grandiosella* by a *Telenomus* sp. (det. Crawford).

Dr. Dyar has been good enough to draw up the following description of the larva of *Diatræa grandiosella* Dyar:—

Head rounded quadrate, narrowing a little below; clypeus high; para-clypeal pieces reaching about two-thirds the height of the front; pale orange-brown; a little darker on the vertex, median and para-clypeal sutures whitish; clypeal sutures dark, mouth black, the color covering the epistoma and bases of maxillæ; ocelli with black central dots, a patch of black covering the lower ocelli; labium and palpi pale; a black triangular spot at side of occiput near the middle; setæ rather coarse, pale, without visible tubercles. Body cylindrical, elongate, moderately robust, tapering posteriorly but only slightly so anteriorly. Thoracic feet moderate, pale brownish, like the head with smoky patches before and behind; abdominal feet very short, thick, the crochets in circles, anal feet somewhat longer, their circle of crochets broadly broken behind. Color whitish with a broad purplish shaded subdorsal stripe, which is quite faint and blotched in the fully grown larvæ. Tubercles large and conspicuous, blackish brown, I larger than II, IV and V forming a single tubercle, VII an elongate patch; on the thorax a narrow chitinous band on the posterior edges of joints 3 and 4 dorsally; tubercles Ia and Ib, IIa and IIb, III and IV, VI with two setæ. Cervical shield large, containing six setæ on each side, pale brown like the head with a pale dividing dorsal line; a small black stain on the lateral margin, otherwise unmarked. Joint 13 rather distinctly divided, its anterior part with the subdorsal tubercles joined over the back by a black stain; anal plate pale reddish brown with three setæ on each side, irregularly joined by brown stains, the plate appearing bimaculate."

Canes damaged by the Gopher (*Heterogeomys hispidus* Le Conte) called "Tuza" in Mexico often contained larvæ of *Metamasius sericeus* Latr. var. *carbonarius* Chev. (det. Schwarz) but in no case was this beetle observed attacking perfectly healthy canes. When the canes were fermenting, from damage done by Gophers or *Diatræa* sometimes they were attacked by *Xyleborus affinis* Eichf. (det. Lt.-Col. Winn Sampson) but this Scolytid was never observed in sound stalks. A Tingid, *Leptodictya tabida* Champ., which Mr. Heidemann has been good enough to describe and figure was not very numerous, and although it damaged the cane leaves in the characteristic way of this family, it cannot be considered a pest at all. The grassy spaces between the fields of canes harbored a great many grasshoppers of different species, some did trivial damage to the cane leaves, but were never numerous enough to make their presence felt. The following genera were represented: *Machærocera*, *Tæniopoda*, *Schistocerca* and *Neoconocephalus*. No doubt these grasshoppers are kept in control by natural enemies, among which there were many insectivorous birds.

The sugar cane leaf serves as food for many caterpillars but at the

Oxaguena Plantation. Mexican ribbon cane, planted 14 months.

time I was there none appeared to be doing any damage. Among the Lepidoptera that were bred from caterpillars I may mention a Syntomid, *Cyanopepla submacula* Walk. (det. Dyar). The Skipper *Perimeles remus* Fabr. was very common in the fields. A few caterpillars belonging to the genus *Cirphis*, which commonly eat the unfolding leaf of the cane were attacked by the parasite, *Horismenus urichi* Crawford (det. Crawford). From the eggs of an undetermined Fulgorid imbedded in the tissue of a cane leaf, I reared a giant Mymarid which turned out to be *Cosmocomoidea morrilli* Howard (det. Howard).

There were numbers of lizards of different species in the fields, which do good work in keeping down insects of all kinds. On reference to Plate 7 it will be readily understood how impossible would be artificial control, such as spraying in a sugar cane field, when canes are any size at all. The only time of the year would be when the canes have just commenced to grow, but then two difficulties crop up, the scant labor supply and the large areas to be treated at one and the same time. Planters must therefore rely on natural control and in Mexico there is a fair amount of it by insects and fungi.

My thanks are due to Dr. Howard and his assistants and to Lt.-Col. Winn Sampson for determinations.

THE SUGAR-CANE TINGID FROM MEXICO

By Otto Heidemann

This neat little hemipterous insect was originally described as *Monanthia tabida* and figured by Herrich Schaeffer 1839, habitat Mexico. F. K. Fieber copied Schaeffer's description and figure in his "Monographie der Tingideæ," 1844. Later, about 1900, Dr. G. C. Champion found specimens of this species also in Panama and Guatemala and redescribed and figured the same in the *Biologia Centrali-Americana*, but referred the species to the genus *Leptodictya*, which had been erected by Stal, 1873, based on some South-American species.

Notwithstanding the fact, that, the characters of the species already are well defined, the writer ventures to give a new description more in particulars.

Leptodictya tabida (H. Schaeff.) Champion.[3]

Monanthia tabida Herrich Schaeffer.[1]

Monanthia tabida Fieber.[2]

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[1] Wanzenartigen Insecten, V, p. 86, t. 173, fig. 535. (1839).

[2] En. Monogr. Tingideæ, 1884, p. 70, t. vi, fig. 1.

[3] Biol. C. Am. II, p. 23, t. 2, fig. 10. (1897–1901).

Body elongate oblong, very flat. Head short with five slender spines, those in front nearly extending to beyond the second antennal joint, the other two diverging from the base of head somewhat upwardly. Eyes rather small, globular, reddish, strongly faceted. Buculæ minutely reticulated, the edge hardly upturned. Sides of rostral groove moderately raised; rostrum not quite reaching the metasternum. Antennæ long and rather thin; basal joints about as long as the apical, which is fusiform; second joint very short; third, four times as long as the fourth. Pronotum narrowing anteriorly, the disk hardly convex, with three linear, low carinæ; interspaces finely punctured; the triangular posterior portion of pronotum quite long, pointed at apex, the surface depressed, closely reticulate; the expanded lateral margins of pronotum are formed by two layers of membrane joined together on the outer edge (viewed sideways) which is cut straight and rectangular anteriorly, the lateral margins are somewhat opaque and have two rows of small areoles. Hood short and with a sharp carina on top, projecting a little in front, but not covering the head, finely reticulated. The elytra transparent, elongate-oval in shape, extending to far beyond the abdomen, the sides feebly rounded, narrowing slightly toward the apex; discoidal area very long, reticulate, the inner nervure, bounding the area, more sharply defined than the outer one, another smaller vein passes along the disk nearly parallel to the inner nervures; subcostal margins narrow, biseriate, costal margins a little broader than the discoidal area with irregular rows of hexangular areoles, those nearing the apex of elytra larger; at the sides anteriorly three or four transverse depressions or folds. Integument pale stramineous; pronotum and abdomen ochraceous; antennæ and legs yellowish-white, claws black. Length 3.8 mm.; width across the widest part of elytra 1.6 mm.

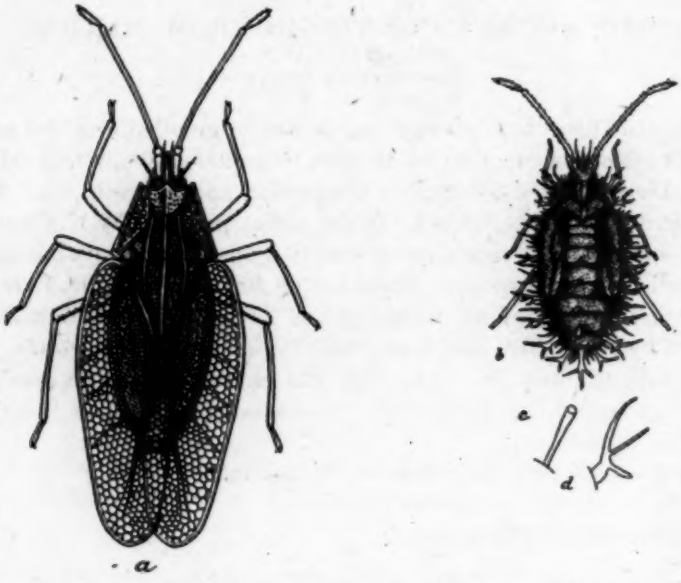

Fig. 1. *Leptodictya tabida*, *a*, adult; *b*, nymph of same; *c*, club-shaped process; *d*, lateral abdominal branched-spines.

Description of the nymph.—Body oblong, rather flat, yellowish-white, densely covered with erect white spinules. The head shows five single very prominent spines. Lateral expansion of the pronotal margins and the sides of body armed with stout, whitish, branched-spines, which are irregular in shape, and at the interspaces are some shorter, single ones. Wing-pads quite long and the posterior triangular portion of pronotum very short. Dorsal part of body ornamented with some peculiar club-shaped processes, which show distinctly an opening at apex. Legs and the underside of body whitish, Antennæ pilose. Length, 2 mm.; width, 1 mm.

Described from several specimens collected by Mr. F. W. Urich on Sugar Cane at Santa Lucrecia, State of Vera Cruz, Mexico, September, 1911.

This species can be distinguished at once by the straight margin of the lateral expansion of the pronotum, which is in the other Central-American species more or less rounded.

THE INSECTS AFFECTING SUGAR CANE IN PORTO RICO[1]

By D. L. Van Dine, *Entomologist, Experiment Station, Porto Rico Sugar Producers' Association, Rio Piedras, P. R.*

Sugar cane has been cultivated in the island of Porto Rico for nearly 400 years. It is only within the last half of the past century, however, that insect pests have been noted affecting the crop and only within very recent years that certain species of insects have given concern to the sugar-cane planters. Those best informed on the subject believe that the sugar-cane moth stalk-borer, *Diatræa saccharalis* Fabr., was introduced into the island in seed cane brought from the British West Indies. It is probable that other species, previously unknown in the island, were introduced in a similar manner, as for example, the leaf-hopper, *Delphax saccharivora* Westw.; the weevil stalk-borer, *Metamasius hemipterus* Linn.; the mealy-bug, *Pseudococcus sacchari* Ckll.; and the scale-insect, *Targionia sacchari* Ckll. Some of these species have appeared in the cane fields within the memory of those engaged in the growing of sugar cane at the present time and the evidence points to their having been introduced into the island along with shipments of their host plant.

When this station was organized a little over two years ago by the Sugar Producers' Association of Porto Rico, the study of the insects affecting sugar cane was one of the lines of investigation provided for.

The writer is indebted to Señor Agustín Navarrete for the loan of a copy of Dr. A. Stahl's "Fauna de Puerto-Rico" which was published

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[1] Published by permission of Mr. J. T. Crawley, Director, Experiment Station, Porto Rico Sugar Producers' Association.

by the author in 1882,[1] thirty years ago. Dr. Stahl records the sugar-cane weevil stalk-borer, *Metamasius hemipterus* Linn., under the name *Sphenophorus sericeus* Latr.; the southern grass-worm, *Laphygma frugiperda* S. & A.; and the mole-cricket, *Scapteriscus didactylus* Latr., under the name, *Gryllotalpa hexadactyla*.

Some seventeen years ago the insects affecting sugar cane in Porto Rico were reported upon by Señor Fernando Lopez Tuero, director of the local Agronomical Station of the Spanish Government, existing at that time in the town of Rio Piedras.[2]

The moth stalk-borer, *Diatræa saccharalis* Fabr., is recorded by Señor Tuero under the common name of "borer" or "gusano de la caña" and under the technical name of *Tortrix sacrifaga*. The mole-cricket, *Scapteriscus didactylus* Latr., is discussed under the common name of "la changa" and the scientific name *Gryllotalpa* sp. The sugar cane mealy bug, *Pseudococcus sacchari* Ckll., is called the "piojo de bolsa blanca" or "queresa" and is determined as *Coccus sacchari*. The May beetle, *Lachnosterna* sp., of the sugar cane is recorded as belonging to the group Melolonthides and is given the common name of "caculo" and the white grub of the same is called the "gusano blanco." The report deals with the habits of the insects, the nature of their injury to the cane, their natural enemies, and the methods of control. It is a most interesting and instructive discussion of the insects known to affect sugar cane in Porto Rico at that time. At the end of the discussion of the insects is given information on injury to cane by rats, the history of the introduction of the mongoose to destroy the rats, the injury by the land-crab, and by live-stock. On pages 105–123 of the report, under the title "Enfermedad de la Caña de Azúcar," the history of the injury to cane by the white-grub of the May-beetle is given and the results of extended investigations on the nature of the injury and remedies are discussed. Altogether the report is a valuable contribution to the subject of Porto Rican sugar-cane insects.

Dr. W. Kruger records the West Indian sugar-cane leaf-hopper, *Delphax saccharivora* Westw., from Porto Rico in a footnote on page 312 in his "Das Zuckerrohr und seine Kultur," published in 1889.

In 1900 Mr. A. Busck[3] records the mole-cricket under the common name of "changa" and states that Dr Stahl of Bayamon determined

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[1] A. Stahl. Fauna de Puerto-Rico. Clasificacion sistemática de los animales que corresponden à esta fauna y catalogo del Gabinete Zoölógico. 1882. Insectos, pp. 82–102; 169–213.

[2] La Caña de Azúcar en Puerto-Rico, su Cultivo y Enfermedad. Por Fernando Lopez Tuero, Rio Piedras, 1895. Capítulo IV, Enemigos de la Caña y Modo de Combatirlos, pp. 63–74. Enfermedad de la caña de azúcar, pp. 105–123.

[3] Notes on a Brief Trip to Puerto Rico in January and February, 1899. Bul. 22 (n. s.), Bur. Ent., U. S. Dept. Agr., 1900, pp. 88–93.

the species for him as *Gryllotalpa hexadactyla*. Mr. Busck mentions *Diatræa saccharalis* Fabr. as being quite bad in some localities and he records the weevil stalk-borer, *Metamasius hemipterus* Linn., under the name *Sphenophorus sexguttatus* Drury. The sugar-cane mealy-bug, *Pseudococcus sacchari* Ckll., is included in Mr. Busck's report and, in further reference to sugar-cane insects, he states that there is "a lamellicorn larva common and destructive to the roots," referring no doubt to the white-grub of the common May-beetle, *Lachnosterna* sp.

In 1902 Mr. O. W. Barrett published a bulletin dealing with the mole cricket or "la changa" in Porto Rico.[1] Mr. Barrett's bulletin is a general account of the life-history, habits, food plants and methods of control of the species in Porto Rico.

In the annual report of the Porto Rico Agricultural Experiment Station, Mayaguez, for the year 1906, Mr. W. V. Tower mentions (page 28) the injury to sugar cane by the moth stalk-borer, *Diatræa saccharalis* Fabr. In the report of the same institution for the year 1907 (pages 36 and 37) Mr. Tower refers to mealy-bug injury to sugar cane and records the shot-hole stalk-borer, *Xyleborus* sp., and the weevil stalk-borer, *Metamasius hemipterus* Linn., under the name *Sphenophorus* sp. May-beetle injury to cane is mentioned by Mr. Tower in the report of the Mayaguez Station for the year 1909 (pages 25 and 26). In the latter report Mr. Tower says: "The larva of one of the Lachnosterna beetles is causing a great deal of damage to the roots of sugar cane; in many instances the tonnage of certain areas has been decreased by its destructive work."

The writer has recorded and discussed the insects affecting sugar cane in Porto Rico in the 1st and 2d Annual Reports of this station.[2] The damage to sugar-cane juice by the moth stalk-borer, *Diatræa saccharalis* Fabr., was reported upon by the writer in a circular of this station published in 1912.[3]

The following is a brief summary of all the species of insects found affecting sugar cane during the two years the entomological investigations of this station have been in progress. The determinations have been made, with few exceptions, by the specialists of the Bureau of Entomology, United States Department of Agriculture, through the kindness of Dr. L. O. Howard, Chief of the Bureau. The entomological investigations of this station are in direct coöperation with

[1] The Changa, or Mole-Cricket (*Scapteriscus didactylus* Latr.) in Porto Rico. Bul. 2, Porto Rico Agr. Expt. Sta., U. S. Dept. Agr., 1902, pp. 19, fig. 1.

[2] 1st Ann. Rpt. (Bul. No. 1), Expt. Sta., Porto Rico Sugar Producers' Ass'n, for the year 1910–1911, 1911, pp. 17–31.

2d Ann. Rpt. (Bul. No. 2), Expt. Sta., Porto Rico Sugar Producers' Ass'n, for the year 1911–1912, 1912, pp. 15–22.

[3] Circular No. 1, Expt. Sta., Porto Rico Sugar Producers' Ass'n, 1912, pp. 11.

the work of the United States Bureau of Entomology on the insects affecting sugar cane in the southern United States.

The moth stalk-borer, *Diatræa saccharalis* Fabr., is generally distributed over all the cane areas in the island and the species is responsible for the greatest amount of damage of any insect attacking sugar cane in Porto Rico. The species was determined for the writer by Dr. H. G. Dyar. The Spanish equivalent for the common name of the insect is "el barreno-polilla del tallo de la caña." The local natural enemies of the sugar-cane moth stalk-borer observed to date are: an egg-parasite, *Trichogramma pretiosa* Riley (?); a Tachinid fly, *Tachinophyto* (*Hypostena*) sp., collected from the gallery of the larva by Mr. T. H. Jones at Rio Piedras, determined by Mr. W. R. Walton; and the fungus parasite, *Cordyceps barberi*, determined by Dr. R. Thaxter of Harvard University.

The injury to the roots of sugar cane by the white-grubs of May-beetles, *Lachnosterna* spp., is the most acute insect pest problem before the Porto Rican sugar-cane planter. The several species involved have been referred to Mr. E. A. Schwarz, who states that some of them are new. Aside from the *Lachnosterna* one other species of the sub-family *Melolonthides* has been collected from the cane field, as well as several species of the related sub-family *Dynastides*, that is, the so-called "hard back" and Rhinoceros beetles. One of the cane field hard-back beetles is a species of the genus *Ligyrus*. The Spanish equivalent for the common May-beetles is "el caculo moreno nocturno" and for the white-grubs, "el gusano blanco." The hard-backs are called "el caculo negro nocturno." The local natural enemies of May-beetles are the wasp, *Campsomeris dorsata* Fabr., bred from the larva of a *Lachnosterna* collected by Mr. C. T. Murphy of Guanica Centrale, determined by Mr. S. A. Rowher; the wasp, *Elis sexcincta* Fabr., collected from flowers by Mr. T. H. Jones, determined by Mr. Rowher; two species of Tachina flies, the first collected by the writer in company with Mr. B. H. Doidge, Manager of the Pagan sugar estate of Guanica Centrale, and the second collected by Mr. T. H. Jones, referred to by Mr. W. R. Walton;[1] and the blackbirds known

[1] Since the above was written Mr. Walton has determined the Tachina fly collected by the writer and Mr. Doidge to represent a new species and the species collected later by Mr. Jones to represent not only a new species but also a new genus. The former species, taken on April 29, 1912, has been described by Mr. Walton under the name *Cryptomeigenia aurifacies* in the Proceedings of the Entomological Society of Washington, Vol. XIV, 1912, pp. 198–200. The latter species taken by Mr. Jones on May 14, 1912, has been described by Mr. Walton under the name of *Eutrixoides jonesii* in Entomological News, Vol. XXIV, No. 2, 1913, pp. 49–51. Both of these flies were discovered at the Librada coffee plantation, Afiasco valley, Porto Rico, as parasites within adult *Lachnosterna*.

locally as "el Judio," *Crotophaga ani* and "el chango" or "mozambique," *Holoquiscalus brachipterus*, determined by Prof. H. W. Henshaw of the Bureau of Biological Survey. Dr. Stahl in his "Fauna de Puerto-Rico" (page 199) records the wasp, *Campsomeris dorsata* Fabr., under the name *Scolia dorsata* Fabr. and the wasp, *Elis sexcincta* Fabr., under the name *Myzine sexcincta* Fabr.

The mole-cricket, *Scapteriscus didactylus* Latr., known locally as "la changa," is common over all the island and is injurious to practically all cultivated plants. Because of the widespread injury of this insect and the variety of its food-plants, it is the most commonly known insect pest in Porto Rico. Fortunately, the injury to sugar cane by the mole-cricket is restricted to the germinating seed cane cuttings and to the young shoots, that is, it does not feed upon sugar cane during the entire growth of the plant. The insect eats into the seed cane after planting and destroys the eye or, more commonly, eats into the base of the young shoot, just beneath the surface of the ground. The symptom of the injury is very similar to that caused by the work of the sugar-cane beetle, *Ligyrus rugiceps* Lec., in young cane in the southern United States. As soon as the young cane shoot has attained some height, and has hardened somewhat, the mole-cricket does not appear to damage the crop further. A further restriction to injury by the mole-cricket is the fact that the insect can work readily only in sandy or loose soils and the cane planted in the heavier clay soils escapes serious injury. The alluvial deposits along river banks and the loose, sandy soils on a plantation are known as "changa" lands. Señor Fernando Lopez Tuero, in his report previously referred to, states that the term "la changa" is the name used in Porto Rico for the reason that the head and fore part of the insect are the shape of a monkey. Señor Tuero says, regarding natural enemies: (Translation) "In the natural struggle for existence, the lizard, which is so abundant in the fields, is an important factor in the destruction of the mole-cricket. The mole-cricket's safeguard consists in its staying hidden during the day, but those which come out of the ground, or, which for any reason, are discovered by their enemy, die immediately.

"Birds and domestic fowls also eat many insects when they are able to find them. The fowls of the plantation, in hunting for their living, always follow the furrow of the plow in order to eat the larvæ of insects and, when they find a mole-cricket, they rush upon it and devour it with preference. The 'mozambique', and many other birds, have the habit of following the furrow of the plow."

The sugar-cane mealy-bug, *Pseudococcus sacchari* Ckll., is found on every sugar-cane plantation in the island. It attacks the cane throughout its growth but the most serious injury noted has been to the roots

of young cane beneath the surface of the ground. The mealy-bug appears to be taken into the cane fields on the seed cane and to develop below the ground about the young and tender roots until the cane stalk has formed sufficient inter-nodes above the ground for the pest to find shelter, at the nodes, beneath the leaf-sheaths. The species was determined as (?) by Mr. E. R. Sasscer. The local natural enemies are the parasitic fungus, *Aspergillus* sp., determined by Mr. J. R. Johnston, pathologist of this station; and the Australian lady-bird beetle, *Cryptolaemus montrouzieri* Muls., introduced by this station in coöperation with the United States Bureau of Entomology. The fire-ant, known locally as "la hormiga brava," *Solenopsis geminata* Fabr., and the ant, *Prenolepis fulva* Mayr., determined by Dr. William M. Wheeler of Bussey Institution, are associated with the mealy-bug in the cane fields, the former species being the more common. The local equivalent for the sugar-cane mealy-bug is "el piojo de bolsa blanca" or "la queresa de la caña."

The West Indian sugar-cane leaf-hopper, *Delphax saccharivora* Westw., is not abundant in Porto Rico but is widely distributed over the island. The common name has been given the Spanish equivalent of "el salta-hoja de la caña de las Antillas." The species was determined for the writer by Mr. O. Heidemann. An egg-parasite, *Mymaridæ*, undetermined; an external parasite, *Dryinidæ*, of the nymph and adult; and a parasite, *Strepsiptera*, of the nymph and adult, have been bred from this species. The egg parasite was collected by the writer and the parasites of the nymph and adult by Mr. Jones.

The West Indian sugar-cane weevil stalk-borer, *Metamasius hemipterus* Linn., has been collected in all of the cane districts in the island but has been observed in injurious numbers in restricted areas only. The species was determined by Mr. E. A. Schwarz. This insect has been given the Spanish common name of "el barreno-gorgojo del tallo de la caña de las Antillas." A weevil root-borer, *Diaprepes* sp., has been found breeding at the roots of cane in several localities. Mr. Schwarz states that this local weevil root-borer is not identical with the sugar-cane weevil root-borer recorded from Barbados by Ballou under the name *Diaprepes abbreviatus*. The weevil root-borer attacks the root-stalk of the plant.

The shot-hole stalk-borer, *Xyleborus* sp., determined as representing a new species by Dr. A. D. Hopkins, is generally distributed over the cane areas of the island. The Spanish equivalent of the common name is "el barreno-agujereador del tallo de la caña." The local observations support the idea that this insect attacks only diseased canes. It is usually associated with the rind disease of the sugar cane, determined by Mr. Johnston as *Melanconium sacchari*.

The cane in Porto Rico is attacked by two species of aphids, the common species being *Sipha graminis* Klt., determined by Mr. Theo. Pergande. Mr. Jones has made a study of the common sugar-cane aphid and has found the following lady-bird beetles feeding upon it; *Cycloneda sanguinea* Linn., *Megilla innotata* Vauls., *Scymnus loewii* Muls., and *Scymnus roseicollis* Muls. The lady-bird beetle determinations are by Mr. Schwarz. Mr. Jones has also collected the larvæ of a Syrphid fly and of a Chrysopid feeding upon the cane aphid, both species being at the present time undetermined.

The southern grass-worm, *Laphygma frugiperda* S. & A., is very often injurious to young cane in Porto Rico, especially after rains, and usually occurs in company with another grass-worm, *Remigia repanda* Fabr., though the former species is the more abundant. These pests are known locally as "los gusanos de yerba." The occurrence of these grass-worms on sugar cane in Porto Rico is the subject of a paper for presentation at this meeting by Mr. Thomas H. Jones, assistant entomologist of this station. Other caterpillars which attack sugar cane in Porto Rico are the larvæ of *Cirphis latiuscula* H. S., another Noctuid; and of *Prenes nero* Fabr., an Hesperid. The determinations of the above lepidoptera were made by Dr. H. G. Dyar. Three species of Tachina flies, namely *Frontina archippivora* Will., *Gonia crassicornis* Fabr., and *Archytas piliventris* v. d. W., determined by Mr. W. R. Walton, have been bred from the larvæ of *Laphygma frugiperda* and a Braconid parasite has been bred from the larva of *Cirphis latiuscula*. Blackbirds feed upon these caterpillars, especially in the more open grass lands.

The sugar-cane scale-insect, *Targionia sacchari* Ckll., determined by E. R. Sasscer, is rather common on cane in Porto Rico, occurring on the stalks, but appears to do no particular damage. The Spanish equivalent for the common name is "el insecto escamoso de la caña."

The adult of *Diabrotica graminea* Balz., known commonly as the green Diabrotica, is found feeding upon the cane leaves. The breeding habits of the species are not known. The determination is by Mr. Schwarz.

A Jassid, *Tettigonia similis* Walk., is found very frequently upon the leaves of sugar cane in Porto Rico but the breeding habits of the insect have not as yet been observed. The species was determined by Mr. O. Heidemann.

Several instances of injury to seed cane after planting by termites have been noted. This species is known locally as "el comején." It is recorded by Dr. Stahl in his "Fauna de Puerto-Rico" (page 207) under the name *Termes morio* Lath.

A leaf-hopper, *Ormenis* sp., has been found breeding on cane leaves in one instance and an undetermined bud-moth (*Tineidæ*) is found at times infesting the cane in rather isolated areas.

Proceedings of the Eleventh Annual Meeting of the American Association of Official Horticultural Inspectors

(*Continued from page 142*)

Chairman E. L. Worsham, of the Horticultural Inspection Section, has appointed the following committees.—[ED.]

COMMITTEE ON STANDARDIZATION OF CERTIFICATES

A. W. Morrill, *Chairman*, Phoenix, Ariz.,
F. L. Washburn, St. Anthony Park, Minn.,
Franklin Sherman, Jr., Raleigh, N. C.

COMMITTEE TO GET OUT A PUBLICATION

Dr. W. E. Britton, *Chairman*, New Haven, Conn.,
Dr. T. J. Headlee, New Brunswick, N. J.,
N. E. Shaw, Columbus, Ohio.

REMARKS ON GIPSY MOTH

By A. F. BURGESS, *Member Federal Horticultural Board*

Mr. President, and Members of the Association: I do not know that I can add very much to what has already been said in regard to the work of the Federal Horticultural Board. As I am located in Massachusetts and have been for several years especially interested in the gipsy moth control work, it might be of interest to some of the members of the Association to learn what is being done to prevent the gipsy and brown-tail moths from spreading to other parts of the United States. After the passage of the Plant Quarantine Law the matter of establishing a quarantine in this section was considered by the Federal Horticultural Board and on November 25, 1912, after public hearings held at Washington, the quarantine was established. Enforcement of the quarantine regulations are in charge of Mr. D. M. Rogers, who is superintendent of moth work for the Bureau of Entomology. The territory has been divided into sections and Mr. Rogers has placed a competent inspector in each section whose duty it is to examine all lumber and forest products which are shipped from that section to points outside the infested territory. Certificates are issued covering such shipments and as transportation companies are prohibited from accepting material of this sort, which is destined to points outside the quarantined area unless accompanied by a certificate of inspection, it is obvious that the country at large is securing ample

protection. All nursery stock going outside the district is examined by federal inspectors or state inspectors who are deputized to act in that capacity so that the spread of the insect is safeguarded when goods of this character are shipped. Some complaint was made during the fall because Christmas trees and greens were not allowed to be shipped to points outside the quarantined area, but as it is practically impossible to make an adequate inspection of this class of material, it was necessary to prohibit such shipments. Some confusion has arisen in regard to the provisions of the quarantine, but for the most part it is working out very satisfactorily and cannot fail to safeguard remote sections of the country from possible introduction of these insects from the infested area. This quarantine is only one of the many beneficial results of the passage of the federal act.

NOTES ON INSPECTION

By F. L. WASHBURN, *St. Anthony Park, Minn.*

The leading points intended to be presented to you in this paper have been practically covered by our discussion with the Quarantine Board last evening. I believe that all of us as inspectors have reason to congratulate ourselves upon the passage of the federal quarantine bill. It gives our actions as inspectors of various states a substantial and authoritative backing never before experienced. This is not only true of inspection of foreign stock, but inspection of domestic stock as well, since nurserymen, rather than see their state or a part of it quarantined will welcome rigid inspection on the part of state officials.

Minnesota has had, apparently, judging from the discussion last evening, the same experience as many other states under the working of this new law. We have found during the last year occasional shipments for which we had received no notice, and also, occasionally apparently more than one notice for the same shipment, and we have sometimes been at a loss to know what shipment was referred to by a notice from the quarantine board, not having upon its face any reference to identification marks. We have further received one or two notices referring to bulbs and bulbs alone, which we understand are not included in the outline of the work of the quarantine board. We feel that the work would be very much strengthened if marks on the packages and their contents were placed upon each notice sent from Washington; but we all realize that it takes a little while for a new law to become established, and I have no doubt but that another year will find the machinery in such good working condition that there will be no delay or confusion or embarrassment of any kind.

In order to conform to this federal law, we propose to have enacted in Minnesota this winter if it is a possible thing, a much more stringent law than we have at present. Under the present law the entomologist only inspects nurseries upon request, or when he has reason to suspect the presence of injurious insects, but even in that event, he can only inspect stock upon premises where it is grown for sale. He is absolutely powerless with reference to private individuals, estates, parks, etc.

Two matters have come to our attention as inspector during the season just passed which are worthy of comment and may have been experienced by officials in other states. In the first instance two or more dealers in a Minnesota city who shipped goods directly from some other state to a patron and, not desiring to advertise the firm from whom they bought these goods, asked us in order that they might conform to the law, to furnish them with a Minnesota certificate signed by the Minnesota official to the effect that this stock was inspected where grown. This request had to be denied, naturally, and we explained to them that the Minnesota official could have no authority outside of Minnesota, and that their difficulty was purely a trade matter which they would have to arrange for without the cooperation of the Minnesota inspector.

The second matter to which I refer is of much more serious import, and one of such a character as to call for some discussion by members of this Association. In connection with the affair just referred to, I found that officials in two Eastern states were certifying that certain dealers in Minnesota owned nurseries in the Eastern states referred to. This testimony was signed by prominent officials and the statements were, of course, absolutely false. I have since learned that this condition of affairs has come to the notice of other inspectors beside myself.

The need of properly qualified inspectors is a fact of growing importance impressed upon us each year. We have been asked by various states to recommend or furnish men for inspection services but we are seriously put to it ourselves to get men properly qualified to take care of our own work in Minnesota, and so serious is the situation that we contemplate establishing a special course in our college curriculum for inspectors. It is evident that deputies sent among nurserymen must be mature men. It injures our work seriously to send boys, or those whom nurserymen might regard as boys to do this work. Further, no matter how efficient an inspector may be as an expert in detecting injurious insects or contagious plant diseases, if he is not able to discuss methods of spraying, different insecticides and spraying machinery in a helpful way with nurserymen and orchardists, he is hardly acceptable to them as an inspector. In other words, an inspector must be an "all around man."

COÖPERATION BETWEEN STATE HORTICULTURAL INSPECTORS

By A. W. Morrill, *Phoenix, Ariz.*

It is not the writer's intention to present in this paper a comprehensive scheme for coöperation among those in charge of state horticultural inspection affairs. Rather he frankly confesses to the narrowness of his experience in this line of work and to his lack of a thorough knowledge of the problems of most of his fellow-workers in other states. This paper is prompted principally by certain problems which confront the inspection service in Arizona—problems, however, which are not peculiar to Arizona, but which the writer is prepared to discuss particularly from the standpoint of the arid southwest.

During the first year's operation of the Horticultural Inspection law in Arizona, the records of our inspection of imported plants showed 8.6 per cent of the shipments from other states to be infested with insect pests. The second year's operation showed a decrease in infested shipments to 6.4 per cent and the third year's to 4.2 per cent. The writer believes he is not ungenerous in ascribing this improvement of conditions not to a reduction in the numbers of insect pests in the nurseries and other plant shipping establishments or to increased efficiency of the officials in other states, who furnished the certificates of inspection, but to the simple spread of knowledge among nurserymen, florists and other plant shippers concerning Arizona's requirements. It is our experience that it is important that information be placed in the hands of not only those who are now shipping plants into the state but those who may do so in the future, in order that they may comply with our requirements, or if impossible to do this, that they may protect themselves by refusing orders from our state. The fact that we propose to inspect all shipments of plants coming into the state affects only in a degree the desirability of having infested shipments kept out. In spite of the best endeavors on the part of common carriers to keep all of their new, as well as old employees informed concerning the matter of holding plants for inspection, occasionally a shipment will be delivered without awaiting for the inspector's release. This is especially likely to occur when the packages, boxes or bundles are not properly labeled to indicate the true contents. It is therefore important, as a matter of protection, that every practicable effort be made to reduce the number of infested shipments entering a state even in the case of those states where shipments of plants are inspected at destination.

Means for Informing Shippers of Plants Concerning State Requirements

In this connection, the writer proposes that this Association provide for an annually revised circular of information containing, in as concise form as practicable, the exact requirements of each state, which are of interest to shippers of plants, and agricultural and horticultural products. The information should include the restrictions imposed by state quarantine orders and for each state should be prepared for inclusion in the circular suggested, by the official in charge of the plant inspection service. Such a circular might appear as a revision of circular No. —of the Bureau of Entomology, providing arrangements for coöperation with the United States Department of Agriculture can be made. In this case, the restrictions upon interstate and international shipments of plants by the National Plant Quarantine Act and by the Quarantine Orders issued by the Federal Horticultural Board might perhaps with advantage be included in the same publication.

It is essential, the writer believes, that such a circular, to serve its greatest usefulness, be revised annually and be issued with regularity on or about October first of each year. The issuance of such a circular would not, however, in itself, fulfill the desired object of placing the information in the hands of those principally concerned. A mailing list for the distribution of the circular should be maintained under the supervision of the secretary of this organization, made up of lists of nurserymen and florists doing an interestate business to be furnished by the officials in charge of the plant inspection matters in the various states. Such a mailing list would, of course, need annual revision.

Need and Means for Better Coördination of Efforts of State Plant Inspection Officials

Practically all of the state horticultural laws require a certificate of inspection from the shipper's home state as a condition for the acceptance of nursery stock importations. Experience in those states where inspections of the shipments are made at destination shows that as a measure of protection this requirement fails utterly to accomplish the desired object. Under present conditions it is even harmful in one respect—it hinders and delays the spread of the system of inspection at destination which has been adopted by only a few states, but which is destined to become general. The additional requirement of some states of fumigation of nursery stock as a condition of entry is, in the writer's opinion and experience, of very little value as far as stock admittedly infested in any degree is concerned.

Arizona, with its insufficient supply of home grown nursery stock

and with its population of more than ordinary cosmopolitan origin, receives nursery stock and other plant supplies from nearly every state in the country. The figures presented in the introduction of this paper for the first season's operation of the inspection law indicate that where the shippers are not fully aware that inspection at destination is practiced, nearly nine shipments out of 100 are actually infested in some degree by injurious insects; moreover these infested shipments are each accompanied by a certificate declaring that the shippers stock has been duly inspected within a year and found free from injurious insects.

The writer has several times been moved to attempt to preserve the dignity of the plant inspection profession by explaining that some insects, although admittedly injurious, are so widely distributed in some sections of the country that further attempts to prevent their spread by means of nursery stock in such sections are of comparatively little value. Let us, however, consider the Eastern peach tree borer. Are there not even in the most generally infested Eastern states, fruit-growing sections, or sections which are yet undeveloped, where this pest does not exist? And is it not the duty of nursery inspectors to give consideration to the protection of such sections.

Dr. O. C. Bartlett, assistant state entomologist of Arizona, formerly deputy inspector in Massachusetts, informs me that in the latter state there are sections which need protection against the common peach tree borer. Doubtless this is true also of practically every state in the East. In the far West, however, the Eastern peach tree borer is very limited in its distribution and in Arizona and neighboring states there is just as much reason to exclude this pest as the San José scale.

Shipments of peaches, plum and apricot trees infested to a greater or less degree by the Eastern peach tree borer have been received in Arizona during the past three years from at least five states located north and east of us. In one case a shipment of about 3,000 peach trees which appeared to be the infested discard of a nursery was received at Phoenix. In this case a certificate supposed to show that the trees had been free from injurious insects when inspected in the nursery, accompanied the shipment of trees which were not only infested, but for the most part virtually killed by insect pests. Trees killed by San José scale could not have been of less value than these girdled peach trees. When notified that the shipment either must be burned or must be reshipped, the nurserymen wired that they expected their "certificate to protect them." Needless to say, it did not. Is it not important that state inspectors, for the sake of their reputations, and honest nurserymen, for the sake of their business, be protected against such an abuse of official inspection certificates?

The writer considers the most important matter confronting this association is the coördination of the work of the state inspection officials throughout the country in order to accomplish the greatest measure of success in preventing the spread of insect pests. Doubtless each member of this Association has ideas upon this subject. The ideas to be presented here are offered as a basis for coördination, which at present is almost entirely lacking, for the accomplishment of the above purpose.

First. We should make this a more effective organization of official horticultural inspectors by securing the enrollment and active interest of the inspection officials in charge in those states not now represented and furthermore we should make this organization a center for active coöperation instead of maintaining it primarily for the purpose of holding annual meetings, however helpful such meetings may be even without further activity for 363 days in the year.

Second. We need a uniform system of nursery and plant certification. Certificates of inspection should mean more than the destination inspections made in some states show them to mean. Assuming that the nursery inspectors in each state make full reports to their chief of all insects injurious or likely to become injurious found in each nursery inspected and assuming that these records are filed, could not a simple system be devised for furnishing the head inspection official in all other states a sworn statement of the actual condition of each nursery as regards insect pests? If the findings show the nursery absolutely free from insect pests, let the certificate be issued in accordance therewith, otherwise I propose that for interstate shipments a certificate be used which will state plainly that the nursery has been found free from pests *with certain exceptions filed with the officials in charge of plant inspections in every state in the country, also that the nurserymen accepting and using the certificate has agreed to use every reasonable precaution against including any infested stock.*

In cases where such a special certificate is issued, the nurserymen should be bound to assume his full share of the responsibility in the matter. For example in the case of the Eastern peach borer, certificates might fairly be issued with the agreement that they are revokable upon the presentation of proof to the chief inspector that such a certificate has been used on a shipment in which more than one susceptible fruit tree in five hundred contained a live borer. Similar arrangements could be made in the case of the woolly apple aphis, perhaps providing for special exterminative treatments in this case. The patrons of the nurserymen concerned could well afford to have added to their bills the slight expense occasioned by such arrangements. If all the states having provisions for nursery inspections

would adopt this uniform system, no honest nurseryman could complain of unfair treatment in the matter.

If such a plan of coöperation as proposed were adopted, much of the clerical work could be economically centralized through this organization. A fixed annual assessment not exceeding $10 for each state would allow a remuneration for the supervisory, and other work of the secretary and pay for all clerical assistance that may be needed.

Is it not both practicable and timely for this organization to consider, endorse and actively promote some plan to standardize the value of certificates of nursery inspection?

WHAT BESIDES INSPECTION?

By H. A. Surface, *Harrisburg, Pa.*

In the official performance of our duties as inspectors, we often feel that more can be done for mankind than mere inspection of property of an owner and notifying him of the absence or presence of pests and means of suppressing them. I do not think there is a worthy member of this association who in his inspection work does not go beyond the mere formalities above mentioned. As officials guarding the welfare of the public, no doubt we all take the new, modern and practical view that "prevention is better than remedy." Note how our health departments and sanitary commissions are turning their attention toward not only the eradication of diseases, but especially their prevention. In fact, all of us who are engaged in the important work of inspection realize that the detection of pests through this service is chiefly for the purpose of preventing their dissemination and, therefore, the work is more preventive than curative. The grower of trees or plants who receives the benefit of this service little realizes what it really means. Without it he would be invaded by pests such as he has not before known, and hence of species that he would not recognize until the damage might be irreparable, or their eradication or suppression accomplished only by extremely expensive means.

We know full well that there are many very serious insects and plant diseases that may yet reach our respective states, and fortunately, for our citizens, have not yet made their appearance within our borders. Can we expect to keep out some of these pests, many of which are more terrible than any we now know, by our own efforts at inspection work, however thorough it may be?

It is always important to know what others are doing in their respective fields, and compare notes in order to adopt the best methods

to our own needs. With the hope of developing discussions that may prove profitable in this exchange of ideas or plans and experiences, we take this subject, and open it for general discussion by stating, first, some of the features of our own work, outside the actual inspection service, to prevent dissemination of pests.

Of course, with the nursery inspection we make a special feature of the San José scale and require all infested stock to be destroyed or removed to another part of the nursery and treated thoroughly with an approved insecticide, like strong lime-sulfur solution, and absolutely cleaned up, before it can be sold or shipped. Also, we follow the regulation method of requiring all nursery stock of kinds liable to infestation by San José scale, grown in an infested nursery, to be fumigated in the prescribed manner, and a certificate of fumigation attached, before it can be sold or transported. We inspect all nurseries during the summer, beginning August 1, and also during the winter, when the deciduous trees are dormant, and pests are to be more easily detected.

All of the above is a regular part of the inspection work. In addition to this more has been found necessary. For example, we have found it necessary to inspect not only the nursery stock, but all the older fruit trees and other trees and shrubs liable to infestation by scale growing in *or near* the nursery. We have found our nurserymen quite anxious to grow clean stock, and to be spared the expense and trouble of destroying infested stock and fumigating that which they sell and ship.

The inspection of surrounding orchards and certain other trees and shrubs has aided greatly in eliminating the original source of the scale, because this inspection, even though not on the nursery property, is followed by compulsory treatment. The infested premises near nurseries are re-inspected, and the inspector makes certain that the scale is cleaned up, before the next season for its spread. Where the owner does not do this according to our directions, we proceed under legal authority to do the work, and the charge becomes a lien upon the property, the same as tax.

In addition to seeing that the premises surrounding the nurseries are kept clean of injurious insects and diseases that would attack the nursery stock or be disseminated thereon, we impress upon the nurseryman the importance of selecting his cions from clean stock.

We know of one instance of a large nursery free from scale, excepting on two varieties of apples. Upon inquiry we found that these were propagated by fruit grafts made from cuttings furnished by a fruit grower of New Jersey, who was anxious to have his own bearing trees used for propagating stock for himself. It is the earnest

opinion of the writer that propagation from bearing trees carries with it more evils than benefits. The cuttings used for this purpose are those that are most sure to carry San José scale and certain other pests to the nursery. In other words, the stock propagated from nursery stock is, as a rule, much cleaner than that from bearing stock. We are willing to go on record further, as having expressed the opinion that cuttings from bearing stock do *not* come into bearing at any younger period than those from nursery stock, contrary to the popular opinion.

Ours must be constantly a campaign of education. We must educate the grower, not only in methods of suppressing pests, but also in methods of avoiding them. To do this we must anticipate what pests may be liable to occur, and instruct the nurserymen and growers who have not had opportunity to make a careful study of this subject. For example, we have had gratifying results by sending to our nurserymen and florists colored picture cards, giving faithful representations of the brown-tail moth and the gipsy moth in their various stages. This is in order to acquaint them with the pests, in order that they can watch for them. In a few cases the growers have immediately declared that *they had such insects on their premises*, but when asked to produce specimens, have been able to show nothing worse than some of the common Noctuids or Cut-worm moths.

It would be best to be on the safe side, however, and be suspicious of any insect that may occur on imported stock, until its real nature is pointed out by an expert. Therefore, we have urged nurserymen and florists to be particularly watchful, and send us specimens of insects in any stage that may be found, in order that we can determine them and give such instruction as may be useful in preventing the spread of the same. It must be said, to the credit or our nurserymen and florists, that they have made good use of the facilities thus offered to them. They have been told that wherever they see a dead leaf held to a twig or to the bark by any means, it is liable to be attached by a web, which means the work of an insect or spider. They are urged to pick off and destroy all such nests with their contents, and wherever these are not well understood, to send specimens at once to the office of the economic zoölogist.

In addition to the above campaign of education and inspection we have tried to educate the final grower or orchardist to recognize the pests on nursery stock and refuse to accept a plant that is seriously infested or infected. Crown gall is one of the serious diseases now causing trouble on stock shipped from other states into Pennsylvania.

In a recent public demonstration a shipment from another state was found entirely infected with this disease. Upon corresponding

with the grower of the stock, he replied that it had been shipped into Pennsylvania by mistake, as it was really packed for shipment to another state. It is certain, however, that it never had subsequent opportunity to get into other hands.

Growers have learned the importance of planting clean, healthy stock, and demand our services quite extensively for the inspection of shipments that they have received both from home nurserymen and those abroad. The inspection service of other states in giving attention to the possible infestation of stock shipped from our own state has been useful in helping to detect infestations, and to make sure that the growers are observing the requirements of our law. It is very advisable to inspect the shipped stock from the home grower, and notify him concerning the findings.

The careful attention that is being given at the present time by the Federal Horticultural Bureau, as well as by the various state inspectors, to imported nursery stock brought into this country by parcels post, as well as by other methods of shipment, is resulting in keeping serious pests out of our country. We hope to see the day when the Federal Horticultural Bureau is supplied with men and funds for making their own inspections, as many of us are working under appropriations that were made to meet the needs of our several states respectively as they exist, without anticipating the heavy demand upon us for federal inspection service, which has recently been made.

Our nurserymen now fully realize their moral sense of duty in preventing the infestation of some otherwise clean orchards, by stock which they may send out, and, fortunately, from this consideration, are guarding against such trouble more carefully than ever before. We feel that the emphasis of the moral obligation in this subject is important, and when we fully realize that in sending infested or infected stock to a man whose orchard may be clean, we are liable to destroy that person's property, as well as ruin our own prospects as nurserymen, we become more careful to avoid such catastrophies.

We hear very little and, indeed, far less than formerly in our state concerning questionable dealing by the tree agent rascal, as was heard a few years ago. We believe that the moral tone given to the nursery business both indirectly and directly through the inspectors' service has had much to do with helping to suppress this old-time fraud.

In many cases we have found demonstrations for the nurserymen quite advisable. It has had a beneficial effect when we have come to their premises to show them how to operate a fumigating box or house, or to show them how to spray thoroughly some of their stock

for certain pests. Our efforts to take up and study their problems, as in our recent investigations of the Bud Mite, published in the *Bi-Monthly Bulletin* of the Division of Zoölogy, can be cited as an example of work for the nurserymen which is appreciated. They have come to regard the inspectors as their friends and helpers instead of oppressors. Their problems are passed on to us for solution, and when they are given practical answers they appreciate the service we thus render to them.

In conclusion, let us say, that besides inspection, we find that no small part of the service to be rendered by the inspector for the benefit of both the nurserymen and the orchardist, is through a campaign of public education in every way possible. By this means the importation of pests to a great extent is avoided, and the dissemination of older pests is reduced to a minimum.

A NEW OPENING FOR ENTOMOLOGISTS: The Agassiz Association, Sound Beach, Conn., is looking for an entomologist, preferably a married man, to lease a building site in Arcadia, erect a small cottage thereupon and devote most of his time to a study of insects. The remuneration offered, as stated by the gifted and enthusiastic president of the association, Edward F. Bigelow, is "the best pay in the world—the joy of doing and the joy of helping." Mr. Bigelow states that he is looking for some one who has retired from the active duties of life and expects to spend the rest of his days in close proximity to the entomological world.

ENTOMOLOGICAL MEETING IN CALIFORNIA, 1915

The Entomological Society of America has received an invitation from the Panama-Pacific International Exposition to hold a meeting in some Californian locality in the summer of 1915. This gathering may be at either of the universities or on the exposition grounds. It has received the enthusiastic support of western entomologists. These latter have attended many eastern meetings and this is an excellent chance for us to return the compliment. It may be possible for a number to go out with a party, stopping off at one or more interesting points en route. As chairman of a special committee to consider this matter and report at the next meeting of the association, the undersigned invites suggestions in regard to this meeting and also expressions relative to the support it would probably receive from eastern entomologists. E. P. FELT, State Museum, Albany, N.Y.

MEXICAN FRUIT FLY (*Trypeta ludens*). Quarantine order number 5 has been emended by the Secretary of Agriculture to prohibit the importation of grape fruit and its horticultural varieties from Mexico.

THE CONTROL OF THE PERNICIOUS OR SAN JOSÉ SCALE

(*Aspidiotus perniciosus* Comst.)

By E. O. Essig

An address delivered at the Convention of the Northwest Inspectors' Association, Spokane, Washington, November 15, 1912

The destructiveness of the Pernicious or San José Scale has been so great and its distribution so rapid throughout this country that it has received more real scientific investigation than has been accorded to any other common pest, excepting perhaps the codling moth, and it is doubtful if even this latter should be made an exception. Indeed, so much has been done in every state to devise new and efficient means of control that I wonder why this subject should have been allotted to me for presentation before such a body as this. Perhaps it is because so much has been written and so little is ever presented in a personal way that much of the real practical information is lost. Climatic conditions so change the modes of operation in controlling this pest that we find certain specialized systems which vary with the different localities. In view of these special conditions I shall attempt to include only those lines of procedure which may be used by all. In fact I believe that the only available suggestions which I can give will resolve themselves into recommendations for the proper application of spraying methods.

The control of all insect pests has usually been directed along purely artificial lines, such as the applications of powders and sprays, and the use of certain gases. In many of the states no other methods have been thought of or attempted. But in justice to all parties, we should recognize here at least two important controlling factors—artificial and natural. The former include spraying, fumigation, etc., and the latter, the importation, establishment and distribution of natural enemies.

Artificial Control. Among the methods artificially used in controlling this pest, spraying is recognized as most efficient in proportion to the cost involved. No doubt fumigation would be more thorough and lasting, but the outlay for equipment, chemicals and the tremendous wear upon the tents, makes this method impracticable. We may also safely say that lime-sulphur is the accepted insecticide. Originally salt was added to make it more severe, which proved as destructive to the trees as to the scale, and like all other detrimental ingredients was left out as soon as this fact was definitely established.

Looking squarely at the problem of the control of this scale at the

present time, I believe that success depends entirely upon four factors: (1) the chemicals used; (2) the dilution necessary; (3) the methods of application, and (4) the time of application.

1. *The chemicals used:* As previously stated, lime-sulphur spray is the proper remedy for the Pernicious Scale. All early experimental work with this spray was necessarily made with the home-made products, and it was several years before commercial spray companies began to turn out first-class and dependable insecticides. In the meantime all published investigations and extension work were based upon the home-made solutions. In fact, we must come down to the last few years to find any number of station bulletins or reports recommending the commercial product. Consequently the growers have been slow to accept anything but those first recommended, and it is little wonder that such proves to be the case. Those of you who have made a special study of the preparation of this spray know that it is difficult to always get a like and satisfactory product, and it is not strange then that the preparations made by the average grower are not only unsatisfactory but often worthless. Practically all of the failures in the control of this scale may be traced directly to these worthless sprays, and I feel confident that success begins with the use of a thoroughly reliable commercial product.

Spray manufacturers are becoming keenly alive to the possibilities of efficient sprays and are now employing the best experts and machinery in the manufacture of their products. The results are so much better than those obtained by even the best home-made solutions that they are being gradually supplanted by the commercial sprays. However, in many sections of our own state the home-made product is still used, and I dare say that a few farmers still persist in adding the salt also. In order to reap the benefits of large purchases the growers of a community should unite in buying the preparations by the carload lot. This is becoming common practice in many parts of California with the result that the growers are now enjoying prompter service and lower prices than they could ever hope to get as individuals.

2. *The dilution necessary:* Too often good material is wasted by improper dilution. The prime considerations are always cost and efficiency; neither of which should be sacrificed for the other. We find one grower applying a spray much too strong at a big cost, while his neighbor is doing the opposite. Of course the extent of infestation, the relative openness and the size of the trees must be taken into consideration. Some growers always make their sprays just strong enough to meet the most favorable conditions, while others aim to provide against all unfavorable factors, and this latter class is certainly more

successful in controlling the Pernicious Scale. The directions accompanying the commercial productions usually give the dilution one part of lime-sulphur to thirteen parts of water. The resultant spray is satisfactory and efficient if all conditions are right, but usually they are not. In our work we are inclined to recommend that the dilution be one to nine, while some growers go farther and say that one to six is not too strong. Naturally we find some difference in the commercial products, but it is safe to say that most of the reputable houses aim to make them all about the same strength; and so we find Rex as good as Ortho, these being practically the only commercial sprays now used in California.

3. *The methods of application:* To my mind the right application of a spray is often more important than any other factor. A poorly made product is often efficient if plentifully and thoroughly applied.

Pumps. Always the first consideration is a good pump. The best, of course, is a power machine. Some hand pumps give fairly good results but for the best work the growers, even those owning ten and twenty-acre orchards, are coming to see the efficiency behind the power sprayer. Many are clubbing together and securing jointly such a machine, which is capable of spraying all their orchards thoroughly several times a year.

Pressure. In application, pressure is the greatest consideration. It must be sufficiently and evenly maintained in order to drive either a fine or coarse spray with force enough to drench the most secluded and protected spots. It should not fall below one hundred and fifty pounds to the square inch, while two hundred pounds is much to be desired, and should be insisted upon.

Nozzles. The spray for the particular pest in question should be fairly coarse and driving and applied with some such nozzle as the "Whirlpool," "Jumbo," "Mistry, Jr.," "Friend," etc., using a large-holed disc. The angle nozzle or a straight nozzle on an angle nipple is certainly an improvement over the old straight form, making it possible to easily and quickly reach any portion of the tree from any position. In our work we use two nozzles to a hose, employing a straight "Y" with angle nozzles, or an angle "Y" with straight nozzles.

Thoroughness. One good application is worth many poor ones. It has been found that one thorough spraying accomplishes as much in controlling the codling moth as three poor ones did under older and more careless methods. The same is true of the Pernicious Scale. Every part of the tree should be drenched. The tops are never exempt, even though some of the material gets into your eyes. It seems to be a common practice to omit the upper third of the tree. Last year I

saw results of a test spraying where whitewash was used, and in almost every instance the tops received no treatment. If the application is thorough the dilution can be greater. The one to thirteen dilution is efficient if the work is good, and the one to nine will give no better results if large patches on the trees are left untouched. I believe that it is better to use an excess of a somewhat weakened spray than to use an insufficient amount of a real strong solution.

In order to make the areas sprayed more apparent and to avoid missing portions of the trees, some of our growers add ten pounds of slacked lime to every one hundred gallons of the diluted lime-sulphur spray.

Under proper management one application should serve to keep the trees in good condition for one or two years.

4. *Time of application:* Fall and winter are the proper times to spray for this scale. It must be remembered that the pest is then more or less dormant. In many parts of California the winters are mild and the resistant powers of the scale are not so great as in the colder regions, and it is quite possible that somewhat better results can therefore be obtained. Though I am not at all familiar with work under your conditions, I should think that it would be advisable to begin spraying in the fall, just as soon as most of the leaves have fallen, and before the scale becomes too dormant.

Natural Enemies. The use of natural enemies has been responsible for much good in many of the states, and especially in California. Many badly infested orchards have been mysteriously rid of the scale much to the surprise of the unsuspecting orchardists. The important natural checks—the internal parasite, *Aphelinus fuscipennis* How., and the predaceous two-stabbed lady-bird beetle, *Chilocorus bivulnerus* Muls., both of which are native insects—are responsible for most of this work. The average orchardist is not content to leave the subjection of the scale to these natural foes, and this attitude has been abundantly justified by the many failures of these beneficial insects. However, they are always to be sought as a valuable adjunct to artificial control and in not a few cases they have proven the salvation of an industry.

Conclusion. In conclusion I might state that under normal conditions the control of the Pernicious Scale in California and elsewhere is exceedingly successful. I can remember when the presence of this pest in an orchard meant complete condemnation of the fruit, while today little is thought of such an occurrence. In fact, many of the localities which were badly infested are today comparatively free of the pest; a condition due to a more thorough understanding of the control methods herein presented.

THE IMPERIAL BUREAU OF ENTOMOLOGY

By C. Gordon Hewitt, D. Sc., *Dominion Entomologist, Ottawa, Canada.*

As the question of international effort and coöperation in the matter of controlling and preventing the spread of insects which in various ways affect human activity is occupying the attention not only of entomologists, sanitarians and workers directly occupied in studying these many-sided problems, but also of statesmen and administrators, the formation in connection with the British Imperial service of an Imperial Bureau of Entomology at the beginning of the present year will undoubtedly interest all concerned in these problems by whom the progress and work will be watched.

This organization is not a sudden development, but a gradual outgrowth of efforts along similar lines which began in the spring of 1909. In March of that year a meeting was called by the Secretary of State for the Colonies at the Colonial Office in London, in which the present writer had the honor to take part, to discuss the formation of an Entomological Research Committee for the purpose of furthering entomological research in the British possessions in tropical and sub-tropical Africa. The chief insects which it was considered desirable to study were those associated with the transmission of disease. In 1909 an Entomological Research Committee of the Colonial Office was appointed by Lord Crewe, then Secretary of State for the Colonies; it consisted of the chief experts in entomology and tropical medicine in Great Britain and Ireland, with Lord Cromer as chairman. Its work fell under three divisions, namely, the carrying on of investigations and entomological surveys in tropical Africa, for the purpose of which two traveling entomologists were employed; the determination of entomological material and the publication of the work so accomplished, for which purpose the *Bulletin of Entomological Research*, a quarterly journal, was started. Through the generosity of Mr. Andrew Carnegie the committee was able also to undertake the training of entomologists for service in the Dominions and Colonies.

On account of the valuable service which was being rendered by the committee to the African crown-colonies and protectorates, suggestions were made for the enlargement of the scope of the work of the committee. Accordingly, in June, 1911, advantage was taken of the presence in England of the Prime Ministers of the self-governing Dominions and a conference was called by the Secretary of State for the Colonies to consider the desirability of further extending the work already begun by securing the coöperation and financial support of the self-governing Dominions and Colonies. By this means mutual

assistance could be rendered by the various countries within the British Empire through the medium of a central bureau, which would be engaged in the collection and interchange of information in regard to noxious insects. It was unanimously agreed that the establishment of such a central bureau was desirable, as it was realized that valuable assistance could be given in the way of disseminating information and other services. Accordingly a tentative scheme was submitted to the governments of the various self-governing Dominions and Colonies for their consideration.

After due consideration a further conference was held at the Colonial Office in August, 1912, to which the government entomologists of the self-governing Dominions and Colonies and others similarly interested were invited to discuss and work out a scheme for Imperial coöperation in preventing the spread and furthering the investigation of noxious insects. At this conference the whole subject was thoroughly discussed and a proposal was evolved for the establishment of an Imperial Bureau of Entomology to be financially supported by the various Dominions and Colonies and the British Government.

It was proposed that the functions of the Imperial Bureau of Entomology should be as follows:

1. A general survey of the noxious insects of the world and the collection and coördination of information relating thereto, so that any British country may learn by inquiry what insect pests it is likely to import from other countries and the best methods of preventing their introduction and spread.

2. The authoritative identification of insects of economic importance submitted by the officials of the Departments of Agriculture of Public Health throughout the Empire.

3. The publication of a monthly journal giving concise and useful summaries of all the current literature which has a practical bearing on the investigation and control of noxious insects.

The scheme was accepted by the various self-governing Dominions and Colonies which were invited to coöperate, and the crown-colonies and British Protectorates will also participate in the advantages of the Imperial Bureau of Entomology which has now been established. The former entomological Research Committee has become the honorary committee of management with the eminent administrator, the Earl of Cromer, as president and the scientific secretary of the committee, Mr. Guy A. K. Marshall, has been made director of the Bureau and editor of the journal. The government entomologists of the Dominions are *ex-officio members* of the committee of management.

The publication of the Bureau's journal which is entitled *The Review of Applied Entomology* was commenced in January. It is being pub-

lished in two parts: Series A, Agricultural and Series B, Medical and Veterinary. As the organization and library of the Bureau becomes perfected, the value of this journal to entomological workers cannot be overestimated, when it is remembered that there are no less than 1700 periodicals, scientific, agricultural and medical which may contain articles dealing with entomology, but a small proportion of which widely scattered entomologists have the opportunity of seeing or the time to consult.

An idea of one aspect of the three years work of the original Entomological Research Committee will be gathered from the fact that the collections received from collectors in tropical Africa and other parts of the world during that time amounted to about 190,000 insects, of which no less than 56,000 were actual or potential disease carriers. The value of this function of the Bureau to entomologists situated in portions of the Empire where there are no collections and little literature to aid in identification will be realised by their more fortunate fellow-workers.

It has been stated that the Imperial Bureau of Entomology will serve the needs of the British Empire in a manner similar to that in which the United States Bureau of Entomology serves those of the United States. This statement, however, is not correct. Its primary function will be that of an intelligence Bureau, collecting information for the use of British countries supporting it, and assisting entomologists and other officials in those countries in the identification of their material. By these methods which have been mentioned and by the publication of *The Review of Applied Entomology*, it will furnish a means of assistance and of coördination of effort in the war against noxious insects which will undoubtedly soon make its services invaluable in the further development of the countries, and especially the tropical and sub-tropical countries, of the British Empire. International as the scope of its enquiries are, the work of the Bureau cannot but prove to be one of the most potent factors in enabling us to develop the agricultural and other resources of the Empire, and our fellow-workers in non-British countries can avail themselves, through its journal, of some of the fruits of the Bureau's work.

THE LIFE CYCLE OF LACHNOSTERNA TRISTIS FABR.

By J. J. Davis, *Bureau of Entomology*[1]

Until the present time the life cycle of but one species of Lachnosterna (*L. arcuata*) has been worked out and recorded in literature.[2] This

[1]Published by permission of Chief of Bureau.

[2]Bull. U. S. D. A., Div. Ent. No. 19, n. s., p. 77.

species was studied by Mr. Theodore Pergande from 1893 to 1895 and found to have a life cycle of practically three years, in the latitude of Washington, D. C., remaining in the grub stage parts of three years, the total larval period being slightly over twenty-five months. It has been the general opinion that all Lachnosterna have a three year life cycle in the northern States and we have much data both from artificial breeding experiments and from field observations to prove that this is the case for many species. One species (*Lachnosterna tristis*), however, has been found by us to be an exception to the rule, it having a life cycle of only two years.

Several pairs of *L. tristis*, collected *in copula* on oak at Lafayette, Indiana, May 13 and 17, 1911, were confined in two twelve-inch standard flower pots which had previously been filled with soil, the top sodded and the pots themselves sunk into the ground. The beetles lived on an average of about two weeks, a rather short period in comparison with other species of Lachnosterna. During life the beetles were supplied with fresh oak foliage every few nights and they were out feeding every night, excepting when too cold or stormy, re-entering the soil each morning. The cages were examined October 9, 1911, and it was then observed that the grubs in these cages were as large or larger than the same aged grubs of other species, although the adults of *tristis* are much smaller than adults of these other species. Owing to the shallowness of the pots the grubs could not enter the soil as deeply as under natural conditions, and it was therefore necessary to cover the tops with a light mulch of manure. Even with the mulch the soil in the pots became saturated with moisture and for several months it was frozen solid. Notwithstanding these apparently unfavorable conditions live grubs were found when the soil thawed in the spring. Complete examinations of both cages were made September 23, 1912, a single adult female *tristis* being found in one cage, while one male and one female were found in the second cage, all occurring in the pupal cells and within an inch of the bottom of the pots which were filled with ten and one-half inches of soil. In neither cage were grubs or pupæ found. These beetles would have emerged in the spring of 1913, which gives a period of two years from the time the eggs are laid until the appearance of the adults above ground, the total length of the grub stage being about one year. All other species of Lachnosterna being studied at Lafayette have a life cycle of more than two years, probably all having a three year cycle, although definite data will not be obtainable for these species until this fall.

From our present meagre data on the economy of this species I conclude that it is one of the least economically important species of

Lachnosterna, although further studies may disprove this conclusion. Dr. S. A. Forbes has listed it as one of the eight species of the genus known to be injurious.[1] In our own collections made in following the plow we have encountered the adult *tristis* but once. A single male in its pupal cell was plowed up April 25, 1911, in an upland clay loam field which was surrounded by general timber. This field had been in corn in 1910, clover in 1909, and oats in 1908, showing that the egg had been deposited when the field was in clover.

ITONIDA ANTHICI N. SP. (DIPT.)

By E. P. Felt, *Albany, N.Y.*

The striking clusters of pinkish white, flower-like galls produced by this species on cypress, *Taxodium distichum*, were collected repeatedly by Dr. W. L. McAtee of the Bureau of Biological Survey, Washington, and forwarded to this office from Mud River, Ark., Carlisle, Miss., and Barachias, Ala. The galls are sometimes so numerous as to dominate the dark green cypress foliage and give the appearance of an ordinary flowering plant thickly set with small blossoms. Dr. McAtee informs us that birds feed upon this gall and upon other cypress midge galls. The larvæ winter within the galls, the pupæ making their way partly out of the side of the gall and the adults evidently appearing in early spring, since this peculiar deformity seems to arise from a leaf bud and is probably a greatly hypertrophid leaflet.

Gall. Blossom-like, a variable pinkish and white. Length 3 mm., somewhat bell-shaped, the margin more or less expanded, sometimes irregularly crenulate and generally enclosing a distinct cup-shaped depression. There is an oval cavity, length 1.25 mm., at the base of the gall, inhabited by an orange-red larva.

Larva. Length 2 mm., oval or narrowly oval, orange-red. Head short, moderately broad, the antennæ short, tapering, biarticulate. Breastbone distinct, greatly expanded apically and with two widely separated, minute, triangular teeth. Skin coarsely shagreened, posterior extremity broadly rounded, nearly smooth.

Exuvium. Length 2 mm., whitish transparent. Thoracic horns rather short, stout, antennal cases moderately stout, extending to the base of the abdomen, the wing cases to the fourth abdominal segment and the leg cases to the sixth abdominal segment, each abdominal segment basally with three or four rows of moderately stout, chitinous spines, the posterior portion irregularly dotted with chitinous points.

Male. Length 1.25 mm. Antennæ ½ longer than the body, thickly haired, reddish brown; 14 segments, the fifth having stems, each with a length ½ greater than its diameter. Circumfili moderately long, stout; terminal segment, basal portion of the stem irregular, with a length thrice its diameter, the distal enlargement irregular, produced, with a length more than twice its diameter, obtuse apically. Palpi; first segment quadrate, the second narrowly oval, the third a little longer and more slender than the second, the fourth ½ longer than the third. Mesonotum dark

[1]Bull. Ill. Agric. Exp. Sta., No. 116, p. 449.

brown, the submedian lines fuscous yellowish. Scutellum and postscutellum fuscous yellowish. Abdomen sparsely haired, dark brown. Wings hyaline, costa dark brown. Halteres dark reddish, yellowish basally. Coxæ fuscous yellowish, the legs mostly dark brown, the tarsi nearly fuscous; claws simple, the pulvilli about ½ the length of the claws. Genitalia; basal clasp segment narrowly oval; terminal clasp segment short, stout; dorsal plate short, divided, the lobes cordate; ventral plate longer, broad, triangularly emarginate, the lobes obliquely truncate; style short, stout.

FEMALE. Length 2 mm. Antennæ ⅔ the length of the body, sparsely haired, fuscous yellowish; 14 subsessile segments, the fifth having the basal enlargement with a length 2½ times its diameter, the circumfili stout and well elevated; terminal segment produced, tapering, with a length thrice its diameter, obtuse apically. Palpi; first segment irregular, second narrowly oval, the third ½ longer than the second, more slender, the fourth ⅔ longer than the third. Abdomen reddish brown, the short ovipositor yellowish. Halteres fuscous yellowish, fuscous subapically. Coxæ and femora mostly fuscous yellowish, the tibiæ and tarsi a little darker. Ovipositor about half the length of the abdomen, the terminal lobes lanceolate, with a length thrice the width, sparsely setose. Other characters practically as in the male. Type Cecid. a2120.

A NEW GALL ON PERITOMA SERRULATUM

By T. D. A. COCKERELL

Galls on Capparidaceous plants appear to be scarce. Houard, in his great work on European galls, cites only two: one, Lepidopterous, on *Capparis ægyptiaca*, the other, Dipterous, on *Capparis spinosa*. The former consists of a globular enlargement of the stem; the latter, due to *Asphondylia capparis* Ruebs., is a deformed and hypertrophied flower-bud. It appears worth while, therefore, to bring forward a quite different gall from Capparidaceæ, consisting of a deformed and enlarged pod, in which Dipterous larvæ live in great numbers.

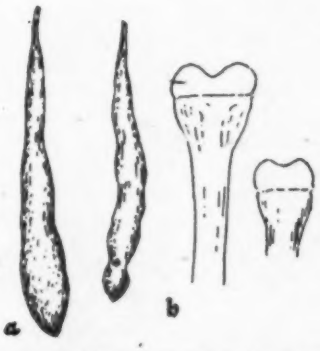

Fig. 2. *Cecidomyia peritomatis*; *a*, galls; *b*, breastbone of larva (original).

CECIDOMYIA PERITOMATIS n. sp.

GALL. A more or less claviform, variously enlarged pod of *Cleome serrulata* = *Peritoma serrulatum*. Frequently the pod is deeply constricted subapically. The larvæ live in great quantities within or among the seeds.

LARVA. Orange, rather slender, 2.5–2.75 mm. long; antennæ conical, acorn-like; mandibles very robust; breastbone with the head about twice as broad as the stem, obtusely bilobed, the median emargination variable, but never very deep, no lateral projections; pseudopods of posterior extremity like the end of a finger, obtuse; bristles of caudal tubercles very short.

HAB. Santa Fé, New Mexico, by Santa Fé River, Aug. 1912. (*Cockerell*). The breastbone may be compared with that of *Thurauia aquatica* Ruebs. (Wien. Ent. Zeit., xviii, taf. I. f. 1.), but it differs in having the head much less abruptly enlarged, and the lobes much rounder and less elongate, the median emargination consequently much more shallow.

CONFERENCE OF FOREST ENTOMOLOGISTS

At the conference of investigators and specialists of the Branch of Forest Insects of the Bureau of Entomology, U. S. Department of Agriculture, held at Washington, D. C., February 26 to March 1, the following subjects were discussed: methods of conducting investigations in the field and laboratories; methods of disseminating information based on the results of investigations, including popular and technical publications, correspondence, etc.; field demonstrations and instructions in the practical details of controlling and preventing depredations by tree-killing and wood-destroying insects; methods of promoting the science and practice of forest entomology; the services already rendered by the Branch of Forest Insects, the services to be rendered in the future, and the relation of the Branch to other branches of the public service and to private interests.

In the discussion of results so far attained it was shown that information on the habits and life history of the Dendroctonus beetles (a group of the most destructive insect enemies of living timber of North America) has been determined and that the practicability of the methods recommended for their control and the prevention of their ravages has been proven by a large number of successful demonstrations conducted during the past six years in coöperation with private owners, the Forest Service, and the Department of the Interior. It was also shown that the published information on the relation of insects to North American forests covers a wide field, both in the line of general information on the entire subject and specific information on the more important insects and problems. It was estimated that a general application of the information already determined and disseminated would save tens of millions of dollars annually to national and private interests in the prevention of waste of forest resources and manufactured crude and finished forest products. It was also shown that the results of original investigations, as published in the technical series of bulletins of the Bureau, have secured for the Branch of Forest Insects favorable recognition and comment among entomologists of this and other countries. In the discussion of the interest manifested it was stated that twenty years ago there was practically no interest in the subject and the idea of any practical means of controlling the depredations of insects in North American forests was not only foreign to the thoughts of foresters and private owners but any suggestion of such a thing was ridiculed. At present there are probably no forest officials who do not know something about the importance of forest insects and the need of protection from

their ravages, and the private owners of forests and the public are beginning to take an active interest in the subject, especially in sections of the country where any attention is given to forest conservation.

In discussing the services to be rendered in the future it was concluded that the greatest present need is in the line of further systematic and economic investigations of the more important injurious and beneficial species and the orders, families, and genera of insects which are represented by species of economic importance, and that specialization by experts should be a primary feature in the policy of the Branch, as applied to systematic and economic investigations and practical details in application.

Following the discussion of the relations of the Branch of Forest Insects to other branches of the public service and to private interests, it was agreed that it is that of the scientific investigator and technical advisor on insect foes and friends of the forest and on methods of preventing unnecessary waste of forest resources. It was shown that a representative of the Branch rendering assistance to another branch of the public service—federal or state—or to private interests—organized or individual, great or small—does so with the idea of rendering a public service through the results of practical application by the beneficiary. Therefore, no direct assistance should be required of such a representative unless there is assurance from the beneficiary that there will be an equivalent return in results which will further the interests of the nation, the state, or a community of local interests.

The present organization of the Branch of Forest Insects, with Dr. Hopkins Chief of Branch, includes four field stations: Station 1 at Missoula, Montana, for Montana, northern Idaho, Wyoming, Colorado, and South Dakota, with Josef Brunner in charge; Station 5, at Placerville, California, for California, Nevada, Arizona, and New Mexico, with H. E. Burke in charge; Station 6, at Ashland, Oregon, for Oregon, Washington, Utah, and southern Idaho, with W. D. Edmonston in charge; and Station 8 at Falls Church, Virginia, for the eastern states, with S. A. Rohwer in charge. These stations do not represent administrative divisions but are centers for the investigation of local problems and for the conducting of instruction and control projects. In addition to the force of three to five men at each station, there is a staff of specialists at Washington engaged in the systematic investigation of the more important orders of insects and special subjects, as follows: Scolytid beetles—A. D. Hopkins; Forest Hymenoptera—S. A. Rohwer; Forest Lepidoptera—August Busck; Forest Coleoptera (general)—W. S. Fisher; Forest Diptera—C. T. Greene; Forest Isoptera—T. E. Snyder; Cerambycid larvæ—F. C. Craighead; and Buprestid larvæ—H. E. Burke.

Some of the special field investigations now under way are—the investigation of chestnut insects and their relation to the chestnut bark disease, general; insect damage to telegraph and telephone poles, posts, mine props, etc., by T. E. Snyder; relation of lightning and insects to the death of trees, by W. D. Edmonston; damage to fire and insect-killed timber by wood-boring insects, by B. T. Harvey; damage to forest tree seeds by insects, by J. M. Miller; damage to reproduction pine by tip moths and pitch worms, by Josef Brunner; the relation of mistletoe and witches broom on living trees to attack by insects, by H. E. Burke.

Experiments are under way to determine the relative immunity of different untreated and treated woods from damage by termites, by T. E. Snyder, and experiments are planned to determine the smallest percentage of an infestation to be disposed of to insure the control of the depredations by the various species of Dendroctonus beetles.

March 12, 1913.

SOCIETY FOR THE ADVANCEMENT OF FOREST ENTOMOLOGY IN AMERICA

An organization to be known as the Society for the Advancement of Forest Entomology in America was effected at a meeting held at Washington, D. C., on March 1, 1913, with A. D. Hopkins, T. E. Snyder, S. A. Rohwer, F. C. Craighead, C. T. Greene, and W. S. Fisher, of Washington, D. C., H. E. Burke and J. M. Miller of Placerville, California, Josef Brunner of Missoula, Montana, and W. D. Edmonston of Ashland, Oregon, as charter members.

The object of this society is to promote a more general interest in the subject of forest entomology and the protection of forest resources from avoidable waste due to the depredations of insects.

Membership is open to persons who manifest an interest in the subject of insects in their relation to the forest resources and the forest products of North America, providing that they are recommended by a member or a responsible person, and the initiation fee of fifty cents and the annual dues of fifty cents are paid to the secretary-treasurer.

The following officers were elected: president, A. D. Hopkins; vice president, H. E. Burke; recording secretary, T. E. Snyder; corresponding secretary-treasurer, F. C. Craighead.

Annual meetings will be held at which the economic side of forest entomology will be discussed, including the reading of papers on the conservation of forest resources. It is intended to publish Proceedings when the Society becomes established on a sufficiently extensive basis. In the meantime papers and discussions of general interest will be presented for publication to forestry, entomological and timber journals.

Persons interested in this movement should correspond with Mr. F. C. Craighead, corresponding secretary-treasurer, Room 410, Evening Star Building, Washington, D. C.

March 12, 1913.

CORRECTION. In the legend of Plate 2, Volume 6, No. 1, all of the figures stated to be enlarged 6.7 times are enlarged about 3.9 times and the one stated to be enlarged 49 times is enlarged about 35.5 times.

Scientific Notes

Insect Collections, Kansas University. The entomological collections of the University of Kansas form a distinct division of the fire-proof Natural History Museum. These collections are increased from year to year in two ways, first, by a regular, organized entomological survey which adds about 25,000 specimens per year, and second, through systematic exchanges with other collections and well known collectors. Last year the 28th annual expedition was in the field twelve weeks.

There are now 984 types in the collections and 300,000 specimens representing 26,000 species.

At the death of the lamented Dr. Snow in 1908 Professor S. J. Hunter, head of the Department of Entomology succeeeded to the curatorship and Mr. F. X. Williams became assistant curator.

The Museum is open to investigators, but types are not loaned. Information, however, is cheerfully given regarding types and when desired drawings are made by the department's artist at a nominal cost. A revised list of types is now being prepared for publication.

Locality Records of the Douglas Fir-Seed Chalcid, (*Megastigmus spermotrophus* Wachtl). In a recently issued review of the literature[1] on chalcids injurious to forest tree seeds, Mr. S. A. Rohwer calls attention to the fact that the Douglas fir-seed chalcid had not yet been recorded as having been reared from the seeds of Douglas fir raised in the United States.

Records in my possession indicate that the infestation of seeds of Douglas fir is probably quite general in Oregon and Washington. Further observations may show the whole region of the Douglas fir to be similarly infested.

I have collected or bred this species from seeds grown in the following localities:

Colville National Forest, Washington.

National Forests, Western Oregon and Washington (seeds mixed).

Tacoma and Olympic National Forest, Washington (seeds of these two localities mixed).

Wenatchee National Forest, (Chiwaukum Ranger District) Washington.

Wenatchee National Forest, (Churnstick Ranger District) Washington.

All localities hitherto examined by me have shown infestation. Up to the time of the present writing I have not examined Douglas fir seed from any other localities than those recorded above.

V. I. Safro, *Oregon Agricultural College, Corvallis, Ore.*

Phytonomus meles Fabr. This obscurely colored clover weevil, kindly determined by Mr. E. G. Titus, appears to be a recent introduction, since there is no record of its capture prior to June, 1907, at which time it was taken in New York by Mr. R. E. Dow. It was reared in our office in July, 1908, from clover collected in the vicinity of Albany, and the latter part of May, 1912, the weevils were observed very abundant on red clover at New Baltimore, N. Y. The insects at that time were feeding upon the foliage and causing some injury. A number of pairs were observed in copulo. Titus has observed the deposition of eggs on and in the stems and leaf petioles of clover and alfalfa, and on the blossoms of clover. Five to seven eggs were deposited in the stems, while elsewhere they were placed singly. European

[1]Bur. Ent. Tech. Ser. 28, Pt. VI.

authors have recorded this insect as feeding upon several species of Medicago as well as *Trifolium incarnatum* in addition to red clover.

The known distribution as given by Titus (Ann. Ent. Soc. Amer. 4:440–41) shows that this European species has established itself pretty well over New England and also in the Hudson valley. It would seem from our observations that the customary early cutting of clover for hay will ordinarily prevent serious injury though this would not apply to sections where clover seed is generally produced. We have, in this species, a recent introduction which will bear watching and may, like its forerunner and ally, the much larger, punctured clover leaf weevil, *Hypera punctata* Fabr., cause considerable apprehension if not serious injury.

E. P. Felt.

White ants, historical. It may be of some interest to Boston readers to know that on November 15, 1883, twenty-nine years ago, the *Boston Evening Transcript* devoted two and one-half columns to an invasion of the State House by White Ants. Quoting from the article: "Now that election is over and the people have had time to shift their thoughts from the governor and his campaign, it would be improper to further delay speaking of the new danger which threatens the Capitol of the Commonwealth. The enemy which has effected a lodgement under the gilded dome is small but mighty and his name is legion. He works in the dark and unceasingly. He would undermine our halls of legislation and offices of state. He is the Guy Fawkes whose plotting is perennial, the blowing up of whose mine is ever imminent. He is at this moment perhaps making ready for the grand overthrow and demolition of the crowning glory of Beacon Hill. His point of attack is at the foundations, and his name is *Termes flavipes* or in vulgar parlance, the white ant."

The room in which they first appeared was in the center of the building and it was feared that if their progress was not checked, the wooden girders might be attacked and result in bringing down the whole structure. If this did not happen, there would at least be some danger to life and limb if the stair supports became infested. In 1882 a document stored in what was then known as the "Dungeon" in the basement of the State House was found to have been eaten in a rather odd manner and Mr. Pierce, then Secretary of State, sent a sample to Doctor Hagen, who at once pronounced it as the work of "white ants." The papers were taken out and sprinkled with insect powder and the contents of the room put in bags and subjected to fumigation with sulphur.

According to the article, Doctor Hagen advised a thorough examination by a competent and conscientious engineer. The shelves of the room where they were found were to be taken out together with the plastering and the woodwork beneath thoroughly inspected. Particular pains were to be taken to find out if the insects had gone up or down stairs. Inasmuch as their presence was suspected in other parts of the building, the expenditure of $1,000 was advised for an examination which might save ten thousand dollars some years later. Doctor Hagen also thought that a standing item for this work should be included in the annual appropriation bill so that the public would be constantly reminded of the danger threatening their capitol and its contents. The nest of the ants was supposed to be in the Common or Public Garden or in an old tree in the vicinity.

Doctor Hagen then called attention to a wooden bridge at Porters Station, which was injured by "white ants" and to an ashpit in the works of Alvan Clark & Sons (makers of astronomical instruments) at Cambridgeport, the posts of which, becoming honeycombed with ant chambers, collapsed some time in 1876. The bridge at Porters Station was supposed to have been selected by the ants on account of its

moist condition, caused by the steam from locomotives which were stopped under it forty times or more every day. The article then quotes at some length from Doctor Hagen's paper "The Probable Danger of White Ants" which appeared during 1876 in the *American Naturalist*.

H. B. Weiss.

Bleeding trees. The exudation of sap and an accompanying discoloration of the bark below, the latter caused in part probably by precipitates, is more or less familiar to all conversant with trees and is particularly likely to occur on sugar maples and the American elm. The causes of this trouble, owing largely to the fact that the flow originates at a somewhat inaccessible point, are not well understood. There may be several factors involved, and observations made by competent parties at different times show that these exudations may be inhabited by Dipterous maggots. Dr. E. B. Southwick mentions this (*Insect Life* 7: 136) and attributes it to the sap fly, *Mycetobia pallipes*, though there is a statement to the effect that Dr. Hopkins then thought it might be due to a species of Sciara.

Last fall we observed numerous larvæ superficially resembling Sciara, inhabiting a somewhat profuse flow of sap originating from a crevice in the trunk of a sugar maple at Kinderhook, N. Y. The point below the injury was brown, corrugated and seemed to be covered with precipitates from the sap. Examination of the cavity showed the larvæ to be present in the deepest portion of the crevice where they apparently kept the tissues in a constant state of irritation. Sap issuing from a similar wound on a horsechestnut trunk was inhabited by probably identical larvæ.

A study of the larva obtained from the above mentioned sugar maple shows that it can not be a species of Sciara and is probably referable to the genus Ceratopogon, particularly as Joseph Mik describes as *C. hippocastani*, adults reared from very similar larvæ which he found in sap from a bleeding horsechestnut. A study of the specimens we collected showed the presence of jaws admirably adapted to gnawing or eroding the more tender cortical tissues. In view of the fact that many of these bleeding wounds are known to be inhabited by Dipterous maggots, some of which at least resemble Sciara larvæ, it would not be surprising if this Ceratopogon or its allies at least, prevented the normal healing of wounds and, under certain circumstances, may be the prime cause of the trouble. The larva is described below in order to facilitate the recognition of this insect.

Larva. Length 5.5 mm., diameter .5 mm., a slender, white larva with a brown or dark head and superficially resembling Sciara. The head has a diameter posteriorly equal to that of the body and tapers anteriorly to an irregularly truncate apex bearing the mouth-parts, the length being nearly equal to its greatest diameter. The mandibles are decurved, apparently biarticulate, the distal sclerite narrowly triangular and apically with a stout, curved tooth, the ventral margin being variably armed with smaller, stout spines. The basal sclerite is subquadrate, with a length about four times its width and articulates with the exo-skeleton of the head and also with a sub-median, slender internal rod extending to the posterior fourth of the head and there articulated with a similar slender member of a hyoid-like structure extending in turn to the posterior margin of the head. The mouth laterally and ventrally appears to be guarded or assisted in its functions by two pair of rounded lobes, each margined with a thick tuft of rather long, recurved setæ. There are other mouth structures which we will not attempt to describe. Antennæ biarticulate, the basal segment with a length $\frac{1}{2}$ its diameter, the apical segment appearing as a very broad, button-like appendage. The exo-skeleton of the head bears a few small setæ, there being apparently four such submedian setæ, one pair near the anterior third, the other near the posterior fourth. There are twelve body segments, the divisions not being well marked. The anterior spiracles terminate in eight slightly thickened, radiating, nearly fused processes on the anterior body segment, and the posterior spiracles are submedian, nearly apposed, the distal portion of the tracheæ distinctly

chitinized. The skin of the body is smooth and a small lateral seta occurs near the middle of each of the anterior two segments. These body setæ, if uniformly present, are extremely fine. There is a fringe of about thirty hairs surrounding the posterior extremity and evidently of service in keeping the larva at the surface when breathing. These hairs are rather stout, adhere apically and form combinations which could easily be mistaken for fleshy lobes. a2364.

E. P. FELT.

Gipsy Moth Conference. On February 22d a conference was held at the office of State Forester F. W. Rane, 6 Beacon St., Boston, at which were present representative entomologists and foresters from the different New England States and New York. Dr. L. O. Howard, Chief of the Bureau of Entomology, and his assistants in the Gipsy Moth work, and Mr. G. E. Clement and Mr. S. W. Dana of the U. S. Forest Service also attended. There were present Mr. E. S. Brigham, Commissioner of Agriculture of Vermont, J. A. Roberts, Commissioner of Agriculture of Maine, Major E. E. Philbrook, in charge of Moth Work in Maine, State Forester Viles of Maine, Prof. W. C. O'Kane, State Entomologist of New Hampshire, Mr. C. H. Hadley, Assistant Entomologist of New Hampshire, Prof. J. H. Foster of the New Hampshire State College, Mr. P. W. Ayers, Secretary of the Society for the Protection of New Hampshire Forests, of New Hampshire, Prof. A. E. Stene, State Entomologist of Rhode Island, Prof. M. R. Blackburn, New York State College of Forestry, Syracuse, N. Y., Mr. George G. Atwood, State Horticultural Inspector, Albany, N. Y., Mr. W. S. Regan, Assistant Nursery Inspector of Massachusetts, Mr. Allen Chamberlain of Boston, Messrs. Bailey, Cook, Gould, and State Fire Warden A. W. Hutchins of the State Forester's office, Mr. H. A. Reynolds, Sec'y, Massachusetts Forestry Association, Dr. W. M. Wheeler of Bussey Institution, Messrs. Rogers, Worthley, and Burgess of the U. S. Bureau of Entomology.

The purpose of the meeting was to discuss the gipsy moth work with particular reference to its bearing on the forest problem. As a result of recent experiments and observations it has been determined that the gipsy moth does not feed as readily on some kinds of foliage as on others, and that there is also a variation in the amount of feeding on certain trees which is done by the small and by the large caterpillars. As a result of this work it is now deemed practicable, in certain types of woodland, to eliminate the favored food plants and in this way the remaining trees are not injured and the territory can be cared for with very little expense. This opens a practical method of handling some of the woodland areas in the infested territory and it is desired to consider this matter from all sides and to secure the interest and coöperation both of the entomologists and foresters in the various states concerned. A report was given of the experiments which have been carried on to secure information on different phases of this work and a statement made of the experiments which it is proposed to conduct during the coming season. The U. S. Forest Service is now working in coöperation with the Bureau of Entomology on the sylvicultural aspects of the gipsy moth problems and Mr. G. E. Clement, one of the trained foresters of that Service, has been detailed to look after that part of the coöperative work. The meeting was of much interest to all the officials concerned, and resulted in bringing up for discussion several features of the work which heretofore had not been taken up in a broad way. It was the desire of all to work in harmony and with as close coöperation as possible, so that the greatest amount of work could be accomplished and unnecessary duplication avoided.

Those present at the meeting were the guests of Prof. Rane at luncheon at the City Club, and it was the unanimous opinion of those present that the conference was of much value, not only to those who attended, but to all the States represented.

A. F. BURGESS.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1913

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—Eds.

The coöperation of those presenting papers at the recent meeting has made it possible to include most of the Proceedings in the first two numbers. The early publication of this matter is very desirable and no more costly than distributing the papers through three or even four issues. It can hardly be expected that subsequent numbers will be equally bulky, owing to our limited resources.

The passing of another of our older members and an associate of Riley in the earlier years, is recorded in this issue. Though restricted by physical limitations and unable to attend our gatherings, Miss Murtfeldt was known by reputation at least, to most of our members. She was deeply interested in the Association and did her part in contributing valuable papers to the published Proceedings. The past decade has witnessed great changes in our organization. Many of the leaders of a few years ago have been gathered home, while others have been compelled to limit their activities or else have turned to other fields. The young man with a speciality is largely in evidence and our meetings depend for success mostly upon the co-operation of groups of specialists rather than upon discussions by general economic entomologists.

The birth of an association for the advancement of Forest Entomology brings to attention another phase of economic entomology. It will be recalled that provision was made by the American Association of Economic Entomologists at the Cleveland meeting for an apiary and inspectors section, each to be presided over by a vice-president named by the section. There must be coöperation among students along special lines if rapid and substantial progress is made. The method is not so important as the attainment of the ideal. No one should object to a sincere effort toward efficiency, and we take this opportunity of extending good wishes to the child. At the same time we would call attention to the parent organization and express the hope that its influence for good in general entomology and even along special lines may not be hampered by the undue multiplication of associations having closely circumscribed activities.

Obituary

MARY ESTHER MURTFELDT

MARY ESTHER MURTFELDT was the eldest daughter of the late E. W. Murtfeldt and Esther Murtfeldt. She was born in New York and there as a child she suffered the serious illness which left a slight paralysis so that in all her after life she was restricted in her walking, otherwise she was robust and her physical infirmity seemed only to intensify her mental powers. With her family she moved to Rockford, Ill., where she obtained such education at Rockford College as books could give. In 1869, the family settled in St. Louis and in 1871 removed to Kirkwood, Mo., a suburb about thirty miles west of St. Louis which offered special facilities for her father's business as an agricultural writer and publisher.

Coming into contact with Dr. C. V. Riley furnished a new inspiration to Miss Murtfeldt's entomological studies and placed at her disposal an entomological library of considerable size. Only those of us who prosecuted entomological studies at that time know how much we were all hampered by lack of entomological literature. Of the students who were active at or near St. Louis at this time, Prof. C. V. Riley, Otto Lugger, Miss Murtfeldt, Mr. Theo Pergande, Mr. Schuster and Mr. Monell, all acquired as years went on a certain amount of entomological eminence and this was largely due to the accessibility of Professor Riley's library and collections.

Miss Murtfeldt died February 23, 1913, at the age of about 65 years, heart disease ending her career after a short illness. Many honors crowned her successful studies. She was elected a fellow of the American Association for the advancement of science, an honorary member of the St. Louis Academy of Science and a member of the Wednesday Club of St. Louis.

Cornell considered itself fortunate in owning one of Miss Murtfeldt's collections of moths and offered her a degree for meritorious work in natural science.

At the time of her decease she was associate editor of *Farm Progress*, a biweekly journal issued by the St. Louis Republic, the principle Democratic daily of St. Louis. She also published under the auspices of the State Horticultural Society an introduction to elementary entomology, intended as an introduction to the more formal treatises of Packard and Comstock

Her first publication was in the *Rural New Yorker* 1873 entitled "Women and Science" followed shortly by a paper on the value of natural science for the Education of Women in 1874 before the Women's

Mary E. Hurtfeldt.

Congress in Boston. After that Miss Murtfeld's publications were mostly on the Tortricidæ in the standard technical journals.

Miss Murtfeldt is survived by three sisters, Misses Louise, Augusta and Josephine and by two brothers, George of Minneapolis and William of Rockford, Ill.

Reviews

Injurious and Beneficial Insects of California, by E. O. Essig. The Monthly Bulletin of State [Cal.] Comm. Hortic., Vol. 2, Numbs. 1 & 2, pp. I–XXI, 1–351. 1913.

The above departs widely from what we usually meet in serials and is in reality a comprehensive discussion of Californian injurious and beneficial insects, the various forms being treated under class and ordinal headings. This work will be particularly welcome to entomologists, since it gives a summary account of the more important injurious and beneficial forms occurring upon the west coast. The usefulness of the volume to the practical fruit grower is greatly increased by the host index of injurious insects, a detailed list arranged alphabetically under the common names of the various plants upon which the insects occur. Naturally, some groups receive relatively more attention than others, this being particularly noteworthy in the case of plantlice, some 44 pages being devoted to the discussion of a number of species, a few of which are probably not very injurious. The scale insects is the banner group, numerous species being discussed and admirably illustrated on 54 pages. The pre-eminence of these pests is doubtless to be accounted for by peculiar climatic and horticultural conditions. Passing to the higher groups we find the ladybeetles or Coccinellidæ given 26 pages, while the major portion of the account of Hymenopterous insects is devoted to parasites. This relative preponderance is to be expected in a region which has been profoundly influenced by the effective work of ladybeetles upon the cottony cushion scale and the potential importance of at least one of the Hymenoptera, namely, the fig wasp, in addition to the good work performed by the numerous small parasites. A discussion of the codling moth parasite which figured so largely in the public prints a few years ago, is limited to a little over a page and gives no hint as to the actual value of this introduction.

A number of eastern insects are noticed in this work, among them being the two species of canker worms, banding being the remedial measure apparently preferred by the writer. The reviewer has favored the application of poisons for these insects, because this treatment is effective in controlling the canker worms and also in checking other leaf feeders very likely to occur upon the trees. We notice an old friend of the east, the forest tent caterpillar, *Malacosoma disstria* under the somewhat anomalous popular name of western apple tree tent caterpillar. In this instance, at least, the official list of common names for insects appears to have been ignored.

There is a chapter on sprays and poisons. The tabulation for the dilution of kerosene emulsion to secure various percentages will undoubtedly prove of much aid to horticulturists and be of service to some entomologists, since occasional errors in respect to this have crept into print. Several types of spray apparatus are figured, including a dust sprayer. There is a detailed discussion of fumigation with several dosage tables. The work is concluded with a compilation of the California horticultural laws and quarantine orders. This bulletin is printed upon excellent paper and illustrated by over 300 figures, most of them excellent and a number being original.

Report of a Trip to India and the Orient in Search of the Natural Enemies of the Citrus White Fly, by R. S. Woglum. U. S. Dep't. Agric., Bur. Ent., Bul. 120, pp. 1-58. 1913.

This is an exceedingly interesting account of a trip in search of the parasites and predaceous enemies of the citrus white fly. The author visited India, Burma, Java, southern China and the Philippine Islands. He found the parasites in India and gives in detail the methods adopted. Vigorous plants were newly infested with the host insect and placed where parasites and natural enemies would have ready access. At the proper time these were shipped in charge of the investigator, and both the parasites and predaceous enemies arrived safely in this country. Unfortunately, conditions in Florida were such that none survived. We fully agree with the author that two men should be sent on such an undertaking and provision made for at least two and, in some instances, we would prefer a series of shipments, since it is easy to see that the material obtained in the first, second or even third might succumb in transit or even some weeks after arrival.

The writer, in addition to the account relating to the finding of natural enemies, gives observations upon the occurrence and habits of *Aleyrodes citri* in India, comparing them with conditions obtaining in Florida. A series of appendices contain notes on Citrus fruits in India, insect pests of Citrus trees seen in various foreign countries, observations on Coccidæ and their natural enemies in Spain, Italy, Sicily and India, and a brief reference to the work undertaken incidentally in fumigating Citrus trees in Spain.

This bulletin is a contribution to knowledge along the broader lines of economic entomology and is an illustration of the cosmopolitan character of the work. We need, in this country, everything that can be obtained in the way of promising parasites or other natural enemies and at the same time we stand ready to demonstrate the efficacy of American measures in controlling insects by artificial means. The former is a logical though rarely entirely efficient method, while the latter is essential in correcting more or less temporary fluctuations in the numbers of injurious insects. It is to be hoped that the Federal government will continue work of this character and at the same time maintain, as has obtained in the past, a conservative attitude as to the benefits, immediate or potential, likely to result.

Red Spiders and Mites of Citrus Trees, by H. J. Quayle, Cal. Agric. Exp't Sta. Bul. 234, pp. 483-530. 1912.

The author places red spiders and mites next to scale insects as the most important enemies of citrus trees in California. The more injurious of these forms is the citrus red spider (*Tetranychus mytilaspidis*) which is noticed in detail, the life history being given and various stages described. The six-spotted mite (*T. sexmaculatus*) and the silver or rust mite (*Eriophyes oleivorus*) are both fully discussed. The familiar clover mite (*Bryobia pratensis*) of the east is better known in California as the almond mite, since it is more injurious to this than to any other fruit tree. The author states that the red spiders and mites live and breed only on the trees. Each female may produce about 30 eggs and there may be from 12 to 15 generations annually, the pests usually being most abundant during May and June. The chapter on natural enemies is particularly full and especially valuable because the biology of a number of forms are given for the first time and there is an attempt to estimate the value of these species as natural checks. The author advises the application of dry sulfur and hydrated lime or the commercial lime-sulfur spray for the control of these pests. The bulletin is printed on excellent paper and most of the illustrations come out very well.

Current Notes

Conducted by the Associate Editor

The death of Mr. L. E. Ricksecker at San Diego, Cal., January 30, 1913, is announced in *Entomological News*.

Mr. A. G. Hammar, assistant in deciduous fruit insect investigations of the Bureau of Entomology, has been sent to San José, Cal.

The Smithsonian African Expedition, under the leadership of Col. Theodore Roosevelt, collected about 3,500 specimens of insects in East Africa.

Mr. Henry L. Viereck has resigned from the Bureau of Entomology at Washington. His address is now 669 Drexel Building, Philadelphia, Pa.

Mr. P. H. Timberlake, formerly of Whittier, Cal., has been transferred to Utah. His present address is 510 Vermont Building, Salt Lake City.

Prof. E. B. Poulton has been chosen as one of three to represent Oxford University at the International Congress of Zoölogy to be held this year at Monaco.

Mr. Quincy S. Lowry of the Massachusetts Agricultural College, Amherst, Mass., has been appointed assistant in entomology, at the Agricultural Experiment Station, New Haven, Conn.

Mr. Harry B. Kirk, assistant in entomology at the Agricultural Experiment Station, New Haven, Conn., resigned March 4, to accept a position in Forest Insect Investigations in the Bureau of Entomology, Washington, D. C.

Mr. Andrew Rutherford of Scotland, has recently been apppinted government entomologist of Ceylon. His address will be, Royal Botanic Gardens, Peradeniya, Ceylon.

Mr. C. T. Brues expects to spend several months late in the spring in Central and South America, investigating disease-carrying insects under the auspices of the newly established School of Tropical Medicine at Harvard University.

Rev. Abbe V. A. Huard, conservator of the Provincial Museum of Quebec, and editor of *Le Naturaliste Canadien* has been appointed entomologist of the Province of Quebec.

According to the *Canadian Entomologist*, Mr. Frederick Knab of the Bureau of Entomology has been appointed honorary custodian of the diptera in the United States National Museum at Washington to succeed the late Mr. D. W. Coquillett.

Mr. Ernest E. Green, government entomologist of Ceylon, has resigned and returned to England. Personal mail should be addressed, Mote Hall, Bearsted, Kent, England, until further notice.

Mr. F. A. Merrick, a well known collector of nocturnal lepidoptera, died at his home New Brighton, Pa., December 16, 1912. He disposed of his collection last year to Dr. William Barnes.

Professor S. W. Williston, University of Chicago, has been appointed delegate at large of the American Zoölogical Society, to attend the Ninth International Congress of Zoölogy.

Prof. R. W. Harned is secretary-treasurer of the Mississippi Nurserymen's Association, and Professor G. M. Bentley holds a similar office in the Tennessee Nurserymen's Association.

Mr. J. E. Buck, M. Sc., has been appointed assistant entomologist in the Alabama Experiment Station succeeding Mr. W. F. Turner recently resigned.

Prof. F. W. Gamble, F. R. S., has been appointed director of a new research department in Agricultural Zoölogy at the University of Birmingham.

Col. W. C. Gorgas, has been granted permission by the United States Senate to enter the service of the Republic of Ecuador, for the purpose of cleaning up the port of Guayaquil.

An excellent article "Sanitation of the Isthmus" of Panama by Joseph Bucklin Bishop, secretary of the Isthmian Canal Commission was published in *Scribner's Magazine* for February, page 234.

According to *Science*, "Prof. Johnathan Hyatt, known for his contributions on insect anatomy, formerly president of the American Microscopical Society, died at his home in New Rochelle, on December 20, aged eighty-six years."

The nursery inspectors of the New England States were invited to attend the meeting of the New England Nurserymen's Association at Worcester, Mass., February 25, and to join in a discussion of the questions of inspection and quarantine. Dr. H. T. Fernald gave a practical and helpful address.

C. W. Hooker, Ph. D., entomologist of the Porto Rico Agricultural Experiment Station and Plant Inspector of the Port of Mayaguez, died February 12. Dr. Hooker was a graduate of the Massachusetts Agricultural College, class of 1906, and received his doctor's degree from the same institution in 1909. He was thirty years of age and his death followed an attack of appendicitis.

Mr. W. F. Turner who has for four and one-half years served as assistant entomologist at the Alabama Experiment Station, resigned January 15, to accept an appointment under the Bureau of Entomology, Washington, D. C. Mr. Turner is now engaged in insecticide testing work and is located at Vienna, Va.

Prof. Charles H. T. Townsend, government entomologist of Peru, has also been designated director of entomological stations, a central station having been established at Lima. The station at Piura will be maintained as a branch, and devoted to agricultural entomology, and a station of medical entomology has been established at Chosica. Mr. E. W. Rust has been transferred from Piura to Lima, and Mr. J. G. Caterino has entered the service. The government contract with Professor Townsend has been extended until December 31, 1913, and several graduates of the school of agriculture will be trained to take up the work.

Mr. C. T. Murphy, for the past five years in charge of the experimental work of Guanica Centrale, Porto Rico, died suddenly of heart failure at his home at hacienda Santa Rita, Guanica, on January 15, 1913. Guanica Centrale is one of the largest sugar estates on the island and in the various plantations of the company Mr. Murphy has carried on extensive experiments to determine the most practical method of controling the various sugar-cane pests, and the best varieties and fertilizers for the various soils and conditions. His wide knowledge of sugar-cane culture made his results of interest to all the sugar-cane growers of the island. Mr. Murphy received his training under Mr. J. R. Bovell, Barbados, British West Indies. Aside from his practical work in the control of insect pests of sugar cane, Mr. Murphy took a keen interest in entomology and while he was not so situated that he could work up a collection of his own, he never lost the opportunity to assist the professional workers of the island in every possible way.

Mailed April 22, 1913.